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OF

Municipal and Private Owned Water Plants of Indiana with the State Board of Health

AT

Indianapolis, July 8 and 9, 1908

Under the auspices of the Indiana
State Board of Health

OBJECT

To study the source of water supplies in Indiana, their preservation
and purification; and to establish standard and
uniform methods of analysis

INDIANAPOLIS:
WM. B. BURFORD, CONTRACTOR FOR STATE PRINTING AND BINDING,
1908.

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PROCEEDINGS.

FIRST SESSION.

Wednesday, July 8, 1908, 10 a. m.

The Conference was called to order by F. A. Tucker, M. D., President of the State Board of Health, who introduced Hon. J. Frank Hanly, Governor.

The Governor extended a hearty welcome to the members of the Conference and expressed his belief in the necessity for remedial legislation to conserve the purity of the water supply.

Hon. Chas. A. Bookwalter, Mayor, followed by extending a welcome on behalf of the city of Indianapolis. Mr. Bookwalter said:

I presume I ought to be able to talk to you in an interesting manner, but this is a subject about which I know but little, although there are some few things which I have come to know about the question of a water supply, because they are the things which most directly concern and affect cities, and to which, as mayor of the city of Indianapolis, I have been compelled to devote some little time. To my mind, the one great problem that will confront municipalities because of this movement that you gentlemen represent here today, is the question of the disposal of sewage. We are inclined in this world to look out for No. 1, and let the other fellow take care of himself; and that is the system that we follow in the question of sewage disposal, not in Indiana alone, but all over this country. I know that here in Indianapolis we are much concerned over the actions of all of the people up in Hamilton and adjoining counties, but they are only concerned in getting rid of that which they do not want, and they pass up to us the problem of handling their refuse when it reaches us in the natural flow of the creek.

The contamination of the streams by cities is the next thing to be considered. I have been watching for it. It will not happen during the time that I am identified with municipal affairs in Indianapolis in an official way, but it is just as sure to come in the new order of things. Indianapolis must some day face the disposal of her sewage and not be content with discharging it into the river.

We have another problem in this city, and that is our water plant, which I am very sorry that we do not own. We have wells in the city of Indianapolis supplying the people with water. In the majority of cases, of course, the wells are furnishing pure water, but as the population increases, and becomes more closely settled, and cesspools and vaults become more numerous, the danger of contamination of the water supply increases out of proportion to the increase of the population; so when some one comes to me and suggests that there shall be no more cesspools in Indianapolis, and I look with favor on the proposition, I am accused, as every other person is accused when he advances a new idea, of trying to boom the business of the plumber in forcing sewage connections, instead of permitting people to build cesspools and vaults in their yards. But I think that the disposal of sewage by the city, after it has been collected in all sections of the town, is the first proposition; and the second is, if we are to continue the use of wells, to compel connection with sewers of every house in Indianapolis, where a sewer is obtainable. We are fortunate in our water supply. This is proved by the experience of the town of Ithaca, N. Y. What could concern us in the towns of New York? But it did concern us when there were brought back to Indianapolis from Cornell University half a dozen boys suffering from typhoid fever, because some careless person along the stream that supplied the water to the city had permitted the source to become contaminated. It did not reach the careless man, because it was contaminated below his water source, which permitted its entry down stream, and hence the epidemic of typhoid fever that had such awful results, not only to the students but to the citizens resident in that town. Indeed, the water supply is an important problem.

This is hardly an address of welcome, but I know it is entirely unnecessary for the mayor, or anybody else, to tell a delegation of Indianians that they are welcome to Indianapolis. Why, we are made up of the other ninety-one counties of Indiana. A night or so ago, while coming down on the car, I was talking to a gentleman who said he was going down to a meeting of the Boone County residents, and to my astonishment he informed me that they had enrolled 2,000 heads of families resident in Indianapolis. If Boone has contributed 2,000 from their county, your counties can certainly make practically seventy-five per cent. of the ninety-one other counties. Hence how unnecessary it is for me to say to a Hoosier that he is welcome to a city of Hoosiers. The health officer, next to the mayor, gets more abuse than any other official that is engaged in public work. I stood night before last in a hall in this city and heard a man beg the health officer of Indianapolis to permit a mother to be taken from a home quarantined for smallpox to the City Hospital to see the father and husband, who was dying. Now, the heart of the man certainly wanted to respond to that plea, but the judgment of the health officer would not permit that to be done. I can appreciate and understand from my own experience the criticisms that are offered to that health officer by the unthinking people in the vicinity.

I believe in this sort of gathering, and the majority of the people in the State of Indiana understand and appreciate its importance. It will only take repeated meetings of this kind to impress upon the majority of the people the importance of the problem that confronts you, and when you have convinced the majority, then will come state regulation of the streams of Indiana, and when that comes, one half of your problem will be solved. You are welcome in Indianapolis, I am sure, and if anything more is required, I will instruct the authorities to give proof that you are welcome.

Dow R. Gwinn, Superintendent of the Terre Haute Water Company, responded as follows:

It is a pleasure to respond to the warm words of welcome we have heard this morning. I was unfortunate in being detained on the road and did not hear what Governor Hanly said. We, over at Terre Haute, appreciate what it is to have a Governor like Governor Hanly, a man who is God-fearing and who is not afraid to do his duty, whatever it may be. We appreciate the warm welcome these gentlemen have given us, and I have no doubt we will get a great deal of benefit out of this Conference. We are gathered here, as you know, to learn what we can about the water question. We have here men who have made a specialty of the water problem, and we want to learn all about this wonderful work. We are all practical men, engaged with practical problems. We believe that Indiana is fortunate in having a State Board of Health like our own. Whether it is in the national associations for the improvement of the health of the people, or whether it is enforcing the

State laws against disease and ignorance, or whether in an advisory capacity in aiding the municipality or county and the water-works officials, the State Board of Health is found doing its duty, although it is sometimes pretty hard to do. The citizens of Indiana may also be congratulated upon having upon their Board of Health men who have a national reputation, who are working for the good of the public health. The State Board of Health has been a great deal of assistance to me, and I have found it a pleasure to work with that Board. Not long ago I was consulted by a water-works official. It seems there had been an analysis made of the city water, and it was unfavorable. My advice was to get into communication with Mr. Barnard, tell him all the facts, and Mr. Barnard would help him. If the water was satisfactory, he would receive a favorable report, but if unsatisfactory, the sooner he could find it out the better. Now, water-works men cannot afford to furnish impure water. The people are entitled to pure water, and we should see that they get it. The lives of little children depend upon the kind of water they get, and surely we should furnish pure, wholesome water.

Ours, gentlemen, is a serious and important responsibility. We ought to work in harmony with the State Board of Health. Let us show our appreciation of the work being done here in the State of Indiana. I thank you for your warm words of welcome, and also your interest in our work.

L. C. Boyd, Indianapolis: I make a motion that the Chair appoint a committee of three, or five, or whatever number he thinks is necessary, to present plans to incorporate a permanent organization of the water officials of the State.

The motion was seconded.

J. N. Hurty, M. D., Secretary of the Indiana State Board of Health, presented the following paper:

HISTORY OF INDIANA'S WATER SUPPLY.

By J. N. Hurty, M. D., Secretary Indiana State Board of Health.

Part I.—Geologic and Economic Review

Ages ago, the area of this globe now known as Indiana, was completely covered with fresh water. A shoreless sea reached from the far north to the far south and from the far east to the far west. Its waters rolled and surged in the continuous night of that period, and again they rolled and surged and were lashed into fury by the winds which blew when God said: "Let there be light."

The land and forests appeared, and on the land and in the fresh seas, animals of most awful form and size and shape roared and bellowed and destroyed each other. As the ages passed, great forests rose and fell and the coal measures and oil and gas were formed. The glacial epoch came and through a period of hoary years sculptured the hills. Then great rivers coursed the State, wearing away the rocks and forming land. Later, lakes and marshes and swamps covered vast areas. The water was limitless. In comparatively recent years, in the days of La Salle (1680), the entire northern part of Indiana was traversed in canoes. Then, White River must have been a great stream capable of bearing the largest modern river steamers. It is possible that at that time there almost existed a navigable water-way from the lakes to the Gulf. What a magnificent stream the Wabash must have been! And the Ohio, still great and majestic, measured its width in miles.

When the State Commission, forty-four years after the Declaration of Independence, in 1820, selected the site of Indianapolis for the capital of the State, they found at the said site a dense forest on both sides of White River. High ground was not wanting, but marshes and swamps lay in all directions. Pogues Run was a fine large stream constantly filled with clear flowing water, never going dry as now, and bearing an abundance of fish life. Fall Creek was then almost a river, capable, save for the overhanging boughs of trees and fallen timber, of being navigated. It, too, abounded in fish life. I have no orderly arrangement of the stories I have heard of the ponds, sloughs and marshes which in later days have been supplanted by factories, business houses, homes, lawns, cement sidewalks and paved streets; but they all show there has been a struggle here to secure dry land to live upon. I have heard my father tell of a trip he made through Indianapolis to the north and west in

1852 to look at land. He found the Fall Creek bottoms a marsh, and he felt it a hopeless task to try to drain the region. In the neighborhood of the Blind Institute his horse walked knee deep in water. Where now spreads the northeastern part of the city, beyond the old Northwestern University, lay Fletcher's Swamp. About where East Tenth street crosses Massachusetts avenue, was a mill-pond which supplied water to a sawmill. A slough existed where the American National Bank building now stands at the southeast corner of Pennsylvania and Market streets. A run or small creek led through this slough to Pogues Run, now confined by stone walls beneath and beyond the railroad tracks leading from the east into the Union Station. Where my own house now stands on Eleventh street, near Pennsylvania, less than forty years ago a pond furnished a skating place in the winter time.

All of this proves the existence, at one time of an extra abundance of water. No one could then have thought that the question of a public water supply would ever come up.

When the marshes and sloughs were drained, it was only necessary to dig six to ten feet to get a never failing supply of well water, and only in favored places were cellars possible. Later, the ground water level having fallen, it was necessary to dig twenty and thirty feet to a supply, and still later there appeared the driven wells, and now we have the deep bored wells, reaching down 250 to 350 feet. In the southern part of the city the factories now race with each other for water. One proprietor, finding his water supply failing, bores his well deeper, and speedily his neighbor must make his deeper, for the first man's wells lower the level. Finally salt water will be reached, and then the reservoir of fresh ground water will be dry, never to fill again as before. And the time has almost come. Having exhausted the lake which existed in the interstices of the earth, where next shall we look for a water supply? Not one business man in ten seems to know that the ground water is almost at the point of exhaustion. At the Commercial Club an enthusiastic group was talking about a city here of 500,000. When the question was asked, where will you get the water for such a city, a successful business man said: ''From the ground, of course.'' And when told the ground was almost exhausted of its water, he called the questioner a grouch and a crank, and moved away with a frown of reproof. Then, those who remembered how eighty-five per cent. of the natural gas was wasted and only fifteen per cent. utilized, and how frowns and epithets were bestowed upon him who dared say there was an end to natural gas, had reason to muse upon the wastefulness and improvidence of those who especially regarded themselves as the only practical ones.

The important problem of the future water supply for Indianapolis and the people of the White River region is upon us. The people must be made to realize it, and without delay, through law, create a White River Sanitary District, wherein the surface water must be carefully conserved and protected from pollution. From the White River watershed must come the future water supply of Indianapolis, Noblesville, Anderson, Muncie and all towns situated thereon. Ownership or control of this shed must be acquired as far as possible; it must be reforested and the cities and towns must be compelled to destroy their sewage in some approved way. The longer this is put off the more expensive and imperative it will become. It is not improbable, however, that it will be put off, for man is prone to practice delay. Many opponents will contend there is no crisis, and that the ground supply is ample. Others will halt at the expense and raise a cry about high taxes, not realizing that the longer the wait, the higher will be the taxes. Still others, being inert, or being old boulders left from the glacial age, will not move in the matter. So those who are alive, those who know good business and true economy, must save the day.

It will not be difficult to draft a law which will create the Indiana Sanitary Water District, which in time can be properly protected against pollution and which can be reforested, and from which will come an abundance of pure water to bring refreshment, health and wealth to the people.

PART II.—HISTORY OF THE INDIANAPOLIS WATER SUPPLY.

It is difficult to realize that Indianapolis was supplied with water from wells only until six years after the Civil War. The city in 1860 contained 60,000 inhabitants, and in the memorable period from 1860 to 1865, soldiers by thousands gathered here, and every drop of water for citizens and the transient multitudes was pumped by hand pumps. The era of public pumps on the street corners began about 1850, for Indianapolis, like other cities in their beginning, took much pride in her big wooden public pumps with their long curved iron handles with knobs on the ends. By 1865 the level of the ground water was so lowered by the general draining and pumping that the shallow dug public wells went dry in dry weather, and it became necessary to dig deeper. Finally, the maximum pumping depth of thirty feet was reached and then came the driven wells, and we heard of first and second water; the "first water" lying above the clay at depths of from 18 to 30 feet, and "second water" lying below the clay at depths of forty feet and more. Of course, the depths varied from these figures in different localities. The first water was usually not extra hard, standing at eight to twelve degrees Clark's scale. The second water was usually harder, standing ten to eighteen degrees, and besides usually contained iron. The iron, however, was not always present, and this was a puzzle which later was explained in part by the fact that the clay blanket underlying the gravel was not continuous, was not without fault. These faults in the clay permitted the first water to fall to the lower stratum—so said the well drivers. This was hardly satisfactory, for the water in "below-the-clay-wells," i. e., the second water wells, always rose to within pumping distance of the surface, and sometimes would flow. Evidently the second water came from a source higher than the first, for it contained no air or gas and could not therefore be forced upward by such pressure. "Second water" was always contracted for when a driven well was put down and frequently a controversy between the proprietor and the well man arose as to what second water was—and had it been reached? A character of the day, Mr. R. R. Rouse, was the driven-well man of the city at that time. I believe there was no other person in the business. He had big wagons and horses with brass-mounted harness, and was a lordly fellow with expansive shirt front ornamented with a large glittering diamond. He claimed to be the inventor of the deep driven well, and pointed to brass plates announcing "patented by R. R. Rouse," on various pieces of well-driving apparatus, to substantiate his claim. Wells were charged for by the foot then, as now, but it was quite a while before all who had wells driven thought to take the trouble to measure them before settling. One day I proposed to measure a public well which had been newly put down near the Union Station and the water of which analyzed badly. Rouse protested it had been measured two or three times, and was found to be eighty-six feet. I grew intensely unpopular with him for insisting, and he stopped the controversy and settled the question for a period by ordering his men to screw on the iron pump. But pumps can be unscrewed, which Rouse knew full well, but he perhaps thought others did not know it. A few days later the well was measured and found to be forty-eight feet, an error of thirty-eight feet appearing. I had a partizan in Rouse before this occurrence, enjoying much analytical water work through his influence; but now I was suddenly found to be unreliable, and strange to say, the public, which I had served, seemed to coincide with him. When it appeared that the first water was going and had become polluted and the driven well was discovered, there seemed to be no apprehension that the second water would not always be in abundance. Councilman Thurston at one time waxed eloquent over "The inexhaustible water supply beneath us which would supply any population for all time. And as for it being or ever becoming polluted, that was nonsense, for beneath the surface lay, as everyone knew, a magnificent and efficient gravel filter placed there by a kind Providence to protect His people." Continuing he said: "The crank," referring to me, "who has sent in this communication warning us against typhoid fever and the possible final exhaustion of the ground water supply should be suppressed as a nuisance." Speaking further he said: "A moment's consideration of the situation will show any one having the least sense that his contentions are all nonsense." His speech was effective. The council evidently agreed with him, for my communication was unanimously tabled, and twelve years passed before it was acted on.

The first water company in Indianapolis was organized in 1869, the ordinance granting the charter was passed in 1870 and the first water was pumped in 1871. The genial and popular Dan McCally was then Mayor and the ever-pleasant and affable Dan Ransdale was City Clerk. The direct pressure system was used, then always called the Holly System. The supply was from a big well on the east bank of White River just south of the Washington street bridge. I guess this well to have been at least forty feet in diameter and fifty or sixty feet deep. It may be there yet for all I know. It was not covered at first, but eventually a roof was put over it. In those days the question of pollution was little thought of; indeed, almost nothing was known of the disease-bearing possibilities of water. Diarrhoea, dysentery and typhoid were then considered among the necessary concomitants of life, an idea that still prevails in many parts of the State. It was the theory among those who had a thought of pollution, that the gravel lying between the river and the well would somehow make the water pure. If it made it clear that was satisfactory, for surely clear water would always be pure.

Time went on, and gradually an unrest appeared among some people as to the excellence of the public water supply. A public service corporation is always a good mark and it is real fun to throw bricks at it. The papers from time to time printed articles which were not in praise of the Water Company, and one day with big headlines it was announced that a blind pipe led from the well to the middle of the river and that the river end was covered with rocks and gravel. This was a great discovery, but an examination of the public plans would have shown any one that this had existed from the first and had never been a secret. It was for emergency in case of a great fire, when the well might be exhausted. The discovery was a great find for the enemies of the Water Company, and the use they made of it was a plenty.

The first works, of which Mr. Denison of Philadedphia was the president, cost over $1,000,000 and was sold by the sheriff. The present company was organized in 1881. The new company immediately realized that a new supply must be secured; that the big well with pipe to a crib in the river would not do. So in 1883 Mr. J. James R. Croes, an engineer of note, was brought out from New York, the place where all good engineers grow, to find a new source of supply. Mr. Croes drove wells almost everywhere from Brightwood to Haughville and in the north and in the south of town. Flowing wells were found along Fall Creek and along the river. I made scores of analyses, being frequently aided by Mr. Croes, who was a good chemist. It is interesting to consider the analyses of those days. We knew nothing of bacteria in water. Franklyn was at that time, with his wife, making the studies which afterward had such broad application. Our opinions were largely controlled by the quantity of chlorine. We decided any amount in excess of three parts in 100,000 was indicative of impurity. The free and albuminoid ammonias were taken, but our technic was so bad that two determinations on the same water at the same time were not remotely comparable. The solid matter, and how it smelled when ignited, we though of great value. Engineer Croes said: "When I can smell a urine odor while burning a residue I feel convinced the water is bad."

Mr. Croes finally decided that a gallery near the mouth of Fall Creek on the north side would be the best thing. The gallery, 1,500 feet long, 50 feet wide and 35 feet deep from the ground level, was begun in 1883 and finished in 1885. It was simply a long well in the ground dug to the water-bearing gravel. In the bottom, several wells driven to the second water flowed perpetually. A second gallery was subsequently constructed along White River, extending north at almost a right angle to the first and was connected with it. The upper end of the second gallery was connected by a pipe with a filter-crib in the river. This connection was for emergencies, and the Board of Health kept a seal upon the valve, which was never to be opened without permission. The galleries furnished a sufficient supply of varying quality for a time (twelve to fifteen million gallons daily), but it soon became evident that they would not long be equal to the demands of the city, and so deep wells were bored in the field north of the pumping station. In 1898, Hill and Jeup, in their report of the examination of the Water Works, said of the supply:

"The present source of water supply is a system of twenty-five deep wells, cased through drift and drilled into the rock to depths varying from 273 to 364 feet from ground level. Of these wells twenty are ten inches in diameter and five are eight inches in diameter. Two other wells, one at the Hoosier Mill and one at Elizabeth street (both ten inches in diameter), are connected with the gravity conduit which supplies water to the Washington street pumping works, their yield being artesian flow. The other wells are operated by air lift and the output averages 9,000,000 gallons daily."

In 1902 the company commenced the present model filtration plant, which is now a credit and an honor to the city as well as to the company. I will not give an account of it, for tomorrow we will see it and have a full description and history.

DISCUSSION OF PAPER.

Mr. Witherell: I want to make a few remarks about the same subject, and I might say that several towns of some of the western states are almost bankrupt. They are allowing private corporations to put in sewerage systems, and the private corporations are receiving seven per cent. on their actual investment, and about five per cent. of that goes to pay interest and two per cent. for expenses and depreciation. That will not always be enough, but in several cases, in one city in the south of about 45,000 people, for instance, that system has been carried on for fifteen or twenty years, and is working admirably. In the State of Pennsylvania at the present time, the debt limit is seven per cent., and when the town cannot put in its sewerage system and disposal works, on account of having exhausted the debt limit, generally a comprehensive scheme is made out, and from time to time this system is gradually paid, sometimes taking ten or fifteen years before it is completed. These are two ways which the general sewerage disposal products are being put in by towns which are not in good shape financially.

Mr. Hubbard, Mooresville: I was thinking of something that may be of some use. Of course the theory as advanced here about the pollution of streams is very important, as anybody can see, but back of all this there are a great many obstructions. And these are some that will have to be taken note of when a bill is proposed: How, for example, can we, in small towns, provide these tanks to take care of our sewage in a sanitary way, instead of going into creeks and rivers, when we are limited by our State Constitution to a bonded indebtedness of two per cent., and when we are also limited as regards what we can tax our people for public works? The objection last winter from the small towns was on this account. They say, we have people here who may die of typhoid fever and other diseases of that sort unless we have sewers, and we feel that we have the right to sewer to the creeks to save our own inhabitants from death, and as sanitation commences at home, we must take care of our own and let the other people take care of themselves. Any bill that is proposed for this measure will be a very weak bill, and it will be a bill that will be opposed by those cities and towns that are already up to the taxation limit, unless it provides some extra way whereby we can take care of the sewers. You cannot blame people for taking care of disease, and if the state laws and restrictions of amounts that you can tax makes it impossible to take care of disease except through rivers and sewers, then you must expect their opposition. I hope when the bill is provided, it will make provision for this contingency.

Mr. Langdon: I believe we are all afflicted more or less with this subject of municipal indebtedness, and undoubtedly we are all interested in the sewer system and shall be glad to lend our assistance in every way possible to prevent the pollution of streams. I believe a gathering of this kind is the nucleus of an organization that will eventually effect the purpose, and I know of no better way—at least it will be my suggestion—than for this organization, at this time, to make itself manifest by appointing a legislative committee and go after this matter as if we meant business. Let us not go home to the people and leave the impression that we just simply met here to hear and discuss a few papers, but that we met here for an object and that we expect to accomplish something. I believe if the people will have the determination to accomplish this, they can have laws so enacted that we can make the debt limit of our cities four per cent. just as well as two per cent. It would be just as well, and even better for the people, because about half the cities in Indiana have an indebtedness of more than four per cent. and it would be much better to have it that way than the way it is, and it is just as well to go after it right, to make the limit so we can prevent the pollution of our streams, put in sewerage disposal plants, and furnish revenue to put in water systems for the benefit of the people that need them. I know of no better way for them to spend their money than in the interests of pure water.

Mr. Kennedy, Rockport: We might be better off having the four per cent. limit. It might be arranged for White River to run up stream, so that the sewerage would come in above the water works, and then they would appreciate the situation. There is only one way to get at this, and that is for each city to take care of its own sewage and have laws passed to make them do it.

Dr. F. A. Tucker: I am interested in the pollution of White River. As Dr. Hurty knows, five years ago, one Sunday morning in February, there were 500 stricken in my town of Noblesville with an epidemic of winter cholera, and holding the honorable position of local health officer, it became my duty to find the cause of this. We found it to be along the bank of White River, about 300 yards above the Water Company's plant, which is situated within thirty feet of the edge of the water. They had five driven wells, ranging from 25 to 35 feet in depth, right in the edge of the water. The ice backed up over the railroad bridge and broke the cap off of the third well. Above these wells were three sewers, emptying into the river. As that water came down stream, it stayed on that side of the river below and when it came to that open well, there was the most beautiful suction formed you ever saw. There were three deaths in our town. The pipes leading from these wells into the reservoir were cut off and sealed. The well is there still. They were compelled to dig some other wells. Last winter we had the same thing, only on a smaller scale. Above the reservoir, there were four sewers emptying into the river within a radius of 60 feet to 200 rods. We had the same thing over last winter as Mr. Barnard well knows. Five sewer tile were broken by the earth packing down upon them, and there was no reason why the sewage should not follow the pipe into the reservoir. Since then our City Council has allowed and has permitted pipes to be built, under each sewer in our city, emptying them into the river above the water works. Now we are willing to empty the sewage below our water works, but we do not care to empty it above. The head of that sewer is in the cemetery. The population of the cemetery is increasing all the time because of people dying from typhoid fever, tuberculosis and other diseases. I am figuring a long ways off, but I personally do not like to drink the sewage that starts in the cemetery. I would rather not. Now, we at Noblesville generally are interested in and a few of us know about stream pollution. Our water company has some very excellent wells, but the pipe is so uncomfortably close to the river that when the river is full of surface water, you can see the water in the reservoir rise in proportion. The water company is also interested in stream pollution.

Mr. Hulley, Marion: While attending the water works convention in Washington, I met Mr. Leighton and had a talk in regard to this matter. He says that Madison County has more wells in the State than any other county, and that the waste of water is just like the waste of gas. You remember all the people wanted to waste gas during the gas boom; they said it never could be exhausted, but it was exhausted forever, and he thinks the waste of water as it is wasted in these flowing wells, will result in the waste of and finally destroy all of our flowing wells. I believe that every person interested, where we have these artesian wells, should make an effort to see their legislators and have a law passed to protect them. I have taken it up already and they say they will do what they can. They all say that such a law can be enacted. There is another law that should be enacted, and that is one preventing draining surface water into our wells, where they do not rise to the surface of the ground. If it is a good well to give out water, it will be a good well to take down water. I know of two instances where the surface water from a farm drained into six deep wells. I came down on purpose two years ago, at the last legislature, to get a law passed to stop it. It is right close to our town and we got all of our water from these wells, and I had the law passed in the Senate and it was ready to go into the House to be passed, but our representative had more interest in Sunday baseball than he had in this law. I know that was the case. I know in our county quite a number of wells that flow hundreds of gallons of water a day that is all going to waste. Indeed, it is not only getting rid of the underground water, but it is lowering it all over the county. Wells that are 60 feet deep are affected by the wells 200 feet deep. There was a question at one time about the upper strata of water being connected with the strata in the lower. Dr. Hurty has been at our place and knows the situation around our water works. We had a series of wells drilled into gravel and they supplied the city for quite a while, but we had trouble with the screens and so went down into the lime, when these gravel wells began to fall. We can start our pumps and it will immediately stop, so there is a connection. I would like to see a law enacted to prevent the waste of this water.

Mr. Barnard: I received this morning a little circular advertising one of our beautiful county seats. On this circular was a picture of the court house, the principal residence streets, and the business blocks, but the greatest feature of the entire circular was an artesian well, which was advertised as giving out water to the extent of 600 gallons a minute. That feature was advertised as being the finest thing that town had to offer for anyone to come there and live—a flowing well that was wasting 600 gallons of water a minute.

THE MORAL RESPONSIBILITY OF WATER WORKS OFFICIALS IN RELATION TO SANITARY PUBLIC WATER SUPPLIES.

By W. E. Taylor, Chief Engineer Terre Haute Water Works.

Modern civilization and its aggregations of population have introduced into our collective life many new problems—problems political, economical, physical and sanitary; and not among the least of the sanitary problems is that of safe and satisfactory public water supplies.

In the earlier years of small towns and sparse settlements, our forefathers drank at pleasure from wells, springs, and surface supplies—wherever the water looked good and tasted right. They drank with confidence, and Mother Nature usually saw to it that the confidence was not misplaced. Then came the time of public water supplies for the larger towns, but the time for any question of the sanitary quality of the water supplied was not yet. It is well within my memory, as it is, probably, likewise with many present, when any matter of purity of supply was the very least of the troubles of water works people; so long as some sort of fluid was furnished and the supply did not fail too often, the work was considered well done. Those of us who were fortunate enough to be connected with a reservoir supply with a moderately good storage capacity, did, indeed, often in times of freshets, cease pumping so long as storage capacity would permit, but this was about the limit of our control. It was taken for granted that the supply must be furnished as found and nothing more was expected by the public.

But conditions affecting unfavorably most sources of public water supplies have developed very markedly during the last few decades; the large towns have become great cities and the smaller towns increased greatly in number and population. As public water supplies have increased in number and extended also to the medium-size and smaller towns, so also have increased in like manner sanitary sewer systems, and as the surface waters are the natural and readily accepted outlet point for sewage systems, it follows at once that, as centers of human activities become more numerous and more congested, so likewise do waste products, both organic and inorganic, increase, and find their way into the streams which usually form the source of public water supplies. This increased density of population and habitation affects not only the public water supplies, but also is admirably adapted to the contamination of those well supplies which many good citizens cling to so tenaciously; the presence of cesspools along with porous sub-strata, the danger of surface contamination, and the disposition of adjacent sewers to leak and find access thereto, all combine to make the shallow wells a source of supply to be looked upon with suspicion, and so markedly has this suspicion proved well-founded, that the health officers of many of our cities and state boards are condemning them on the general grounds as stated.

This, then, being the case, that our usual sources of public water supplies have become so contaminated that they may not be safely furnished as found, there are just three courses open to those water works officials who wish to do their whole duty: 1st. A supply from some more or less distant watershed where there is very little; if any, danger from contamination. 2d. A source of supply from deep wells, or infiltration galleries. 3d. The filtration and purification of those surface supplies which have been our main standbys in the past, and which will also likely be so in the future, the rivers, streams, and lakes adjacent to the community to be supplied.

As to the first and second methods, it is true that some works, and some very important ones, are now getting or planning to get good supplies by one of these methods, but it is also true that in the great majority of cases, the third method must, because of physical limitations, be the method that must be relied upon. And happily it is for us all that, as the demand for sanitary water began to make itself heard from the public and from our water works officers, our American engineers, inventors, and sanitarians began to rise to meet the demand.

Methods taken from continental practice, and the more distinctive American methods have been so expanded and improved in detail until now it is plain that a public water supply furnished otherwise than clear, bright, colorless, free from matter in suspension and disease-producing organisms, is so furnished only because those in charge either will not, or can not, by reason of the expenditure involved, avail themselves of modern filtration and purification processes.

It is not my purpose to discuss the various forms and modifications of water purification processes; circumstances alter cases, and that plan which best meets the necessities of one water supply is not necessarily the best for another. This is an era of specialization, and, as a general rule, the proper procedure in the improvement of any given supply is an expert study of that particular supply and plans made in harmony with the needs of that supply as indicated by such study.

It is not intended to indicate that the last word has been said, the ultimate attained, in water purification processes; our present knowledge shall serve as a basis for future improvement and the years to come may see many changes in detail, one of the possible lines of development being that in which processes and reagents may be safely adapted to exercising a selective, destructive efficiency as to the pathogenic organisms. But the art and practice of water purification as it exists today seems to be founded upon such a plane of stability that there is no more danger of such plants becoming obsolete in their main features than there is regarding other classes of water works machinery and methods.

As to the efficiency of modern filtration and purification processes, an examination of the death rate, by reason of transmissible water-borne diseases, in those cities which have placed their water supplies upon a sanitary basis, and comparison with the time before such had been done, and also with other cities where such action has not been taken, establishes beyond doubt the value and efficiency of the process. Let it be said, however, and emphasized in the saying, that however wisely a water purification plant may be designed and however well it may be built, its value and efficiency can only be fully attained by proper management, and the tendency of the day, even in plants of moderate size, is toward controlling the plant and checking its continuous efficiency by laboratory methods.

There is another word which may be said here, and this is more of a foreword than otherwise, and that is in regard to those dissolved inorganic matters, the salts in solution which give water its hardness. It seems to me that this matter is one which is certain to receive much more attention in the future than it has in the past. It is well known that hard waters are not well adapted to boiler uses, the salts being deposited upon the heating surfaces in the form of scale, rendering frequent cleaning necessary, and impairing to a certain extent the efficiency of the boiler as a steam generator. It is also well known that hard water is not so satisfactory for domestic use as soft water, the hard water requiring much more soap to make it effective in cleaning work, but if the necessary expenditure for soap in any given city as between hard and soft water were tabluated, it is probable that both the sum total in each case and also the difference would be surprising.

As to the comparative physiological effects of hard and soft waters, the question as to which is the better for potable purposes, it is possible that any expression of opinion on this matter may be transgressing into the domain of the physician and physiologist, but I believe that this question merits more attention than has been given it. If I remember rightly, there was a proposition advanced by a German scientist some years ago to the effect that no solids of inorganic origin were assimilated into the human system and used in its normal composition, and if this be true then does it not follow that in those waters which contain much inorganic matter in solution, that the salts must be expelled at the expense of the vital economy, or partly retained in a substitution for or aggregation to the bodily structure at the expense of structural strength and functional activity. True it is that the human system possesses a wonderful adaptability; no other animal can exist and adapt itself to such wide variations of environment and sustenance as can man, but the fact that life and activity exist with any given conditions does not assure us that those conditions are necessarily the best.

Whatever may be the future decision as to this particular point, there is no question about the moderately soft waters lending themselves more readily than do the hard waters to ordinary domestic and manufacturing purposes. The matter of water softening for public supplies appears to me to be at present more of a question of financial practicability than a question of possibility or desirability; but some time perhaps the householders will learn that it is wisdom to spend a few extra dollars in water rates in order to secure a soft water supply and to receive several times the value of the expenditure in less soap and more satisfaction.

Passing on, however, more to the purpose of this paper and assuming that it has been shown that which, in fact, is a matter of common knowledge—that most of the sources of public water supplies of today are contaminated, and also that means are known by which such supplies can be treated and furnished the consumers in such a state as will satisfy both sanitary and aesthetic requirements, brings us directly to the thought involved in the title of the paper—the moral responsibility of water works officials as to installing modern processes of water purification and then seeing to it that the operation of the plant is placed on such a basis as will insure uniformly good results. And in the consideration of this matter of moral responsibility, there is absolutely no new determining principle—the principle is as old as is humanity. Six thousand years ago when the human race was an infant, the question was first asked, "Am I my brother's keeper?" and the answer in affirmation was the brand upon the brow; fifteen hundred years later the Mosaic law reaffirmed it in specific directions; the advent of Christianity, restated, revivified and extended it; the French revolution, with all its horrors, was the inevitable result of the negation of the principle as applied to the peasantry of that country; the last two wars in which this government has engaged have been in practical recognition and application of the principle involved in the old question. And coming now to our present day, what means the growing wave of reform, the ozonization of the moral atmosphere that is touching with salutory hand many of the things which we once thought of with indifference, if at all. What is the significance of the laws that are being passed against stunting childhood by labor, by laws limiting the hours of labor where the safety of the public may hang upon such limitation, by laws which aim to save men from their vices whether they would or not? What is the meaning of the gathering here today? It all and many other such things are just sign posts indicating that more and more are we coming to realize that all things that affect the health, happiness and prosperity of the individual affect in like manner our nation as a nation, and that more and more are we coming to feel that as individuals, or as individuals merged together as corporations, municipal, state, or national governments, we are, up to the full measure of our talents and opportunities, morally responsible to all others so far as our acts of commission or the thing of omission may affect others.

Gentlemen, accomplishment is seldom higher than ambition—our wagon still must be hitched to the star; and so it is that the advanced sanitarian of today, inspired by the message left to the world by Louis Pasteur, has a vision—a vision of that time when those unseen foes, the pathogenic organisms that today afflict mankind shall not dominate as they do now, when by reason of right conditions, more fully known than now and much more fully enforced, such things as tuberculosis, typhoid and other forms of transmissible disease shall be known only in isolated cases if at all; shall be known as something that afflicted us in the past, but which have by intelligent and well-directed human endeavor been practically stamped out. And this vision is no idle dream, but is rather a goal already set up, and there seems to be no good reason why it may not be reached; and in the accomplishment of this purpose, it is both your privilege and your duty to have a part, a place and a part in the attainment of that goal which shall mark the better time when *all* infectious diseases shall be banished from the face of our fair land.

UNDERGROUND WATER SUPPLY OF INDIANA.

By Frederick G. Clapp, U. S. Geological Survey, Washington, D. C.

Importance of the Underground Water Supply.

During the past few years increasing attention has been paid to waters obtained from underground sources. This has been due in part to the reduced cost and improved methods of drilling deep wells, and in part to the greater realization that many surface waters, particularly in the central states, are unsuitable for drinking. The first concern of a city, town or institution in installing a water supply plant should be, and generally is, the quality of the water as adapted to drinking and other domestic purposes. A surface water may be so soft as not to cause the least scale or corrosion in boilers, and yet be so badly polluted with sewage or other filth as to be unsafe for other purposes. Thus it is that many railroads and manufacturing concerns cling to river or creek water as essential to their operation where it can be obtained, while cities and towns, on the other hand, have abandoned surface waters almost entirely in favor of deep wells. In the rural districts, too, underground waters are necessary for domestic purposes and farm supplies.

The importance of the underground water supply and the demand for accurate information regarding it have led the United States Geological Survey to make detailed studies of the underground waters in Indiana and other States. During the summers of 1906 and 1907, Messrs. F. G. Clapp and S. R. Capps spent several months in portions of northern and eastern Indiana investigating ground water supplies for the U. S. Geological Survey, and a mass of information has been obtained which is being assembled for publication in one of the regular series of water supply papers issued by this bureau. The reports in question have contributed to a better understanding than ever before of the conditions which prevail in various geologic formations and their relation to the quality and relative abundance of water in each. As a result of this investigation, several unexpected results have come to light, as, for example, the great amount of artesian water that is going to waste; the unnecessary and serious pollution of surface and ground waters that is going on everywhere; and the necessity for laws to prevent these evils.

Comparison of Water Works Using Underground Supplies with Those Using Surface Supplies.

The area investigated includes nineteen counties in north-central Indiana, extending from the southern boundary of Hendricks, Marion and Hancock counties, northward to the Michigan line. Practically every city, town and village in this area was visited and conditions in the country districts were investigated, as well as those in the towns. While, on the whole, the geologists were impressed with the excellent quality of northern Indiana water, this must be recognized as due not entirely to real superiority over other regions, but largely to the fact that the progress of civilization has driven all enterprising communities, as well as individuals, far below ground in search of more potable supplies than can be obtained on or near the surface.

It has been interesting to compare the towns using underground waters with those using waters from surface sources in the nineteen counties studied. Of the fifty-four communities having public supplies, two use lakes, three use streams, three use both streams and wells; one town uses springs and forty-five use wells alone. In other words, forty-nine out of the fifty-four communities obtain all or part of their water from underground sources.

In order to compare the quality of surface and underground waters a table was compiled giving the sources and sanitary character of waters of all public supplies in the nineteen counties. From this it was found that of the five communities using lakes and streams none could be said to have water of desirable quality; of the three communities which have both streams and wells one, Indianapolis, has good water, chiefly because the city has installed an excellent filtration system. Out of the forty-five communities that use wells alone, forty-one were found to have water of the best potable quality. A similar proportion exists in other states that have been investigated.

Nearly all the wells used for town supplies are deep drilled or driven wells, but a few towns use open wells. As a rule, open wells are fully as objectionable when for public supplies as when used for private houses, for they allow the entrance of surface drainage and infiltration of the polluted waters which are present in the upper strata of sand or gravel.

SOURCES OF QUALITY OF UNDERGROUND SUPPLIES.

The ground waters of the State are derived from the glacial drift which underlies it in depths varying from a few feet to several hundred feet in the northern counties, from the alluvial sands and gravels of the river bottoms, or from the sandstones, limestones and shales of the various geologic formations beneath the drift. The waters from all these water-carrying beds contain mineral matters in solution, the quantity and character of the constituents depending upon the formation from which the water is derived and upon the depth of the well. The analyses may be summarized by stating that practically all limestone waters and waters from gravel wells over 50 feet deep are to be preferred for domestic purposes to waters from gravel wells less than 50 feet deep. For manufacturing or boiler purposes, surface waters are superior, but of the ground waters, those from wells in gravel and between 50 and 100 feet deep average better than others, in that they show the lowest maximum, lowest minimum and lowest average amounts of scale-producing minerals.

FLOWING WELLS.

Scattered throughout the State are many localities of small extent where flowing artesian waters can be obtained. The flows are due to one of two causes: (a) Where the water is struck in the Niagara limestone it may owe its head, in certain cases, to the pressure derived from its highest elevation, about 1,200 feet above tide near the Ohio line east of Randolph and Wayne counties, Indiana, where the Niagara limestone reaches the surface 200 to 400 feet higher than its usual altitude in Indiana, in which class some of the flowing water from gas wells may belong; (b) the large majority of flowing wells, however, particularly those along valleys, are believed to owe their head to local causes—to the transmission of pressure from some neighboring elevation in the drift-covered surface of the State. The flows in some rock wells, as well as in drift wells, belong in the latter class. The pressure is transmitted from the water stored in the drift to that contained in the limestone below.

Well known examples of flowing wells are situated along Wabash River, White River and Fall Creek. The towns of Danville, Wabash, Middleton, Portland and North Manchester are fortunate in getting their supply by a flow which saves the expense of pumping.

DECREASE IN THE UNDERGROUND WATER SUPPLY.

Such conditions are not destined to last, however, unless proper precautions are taken. For the past few years the ground water level beneath large areas has been falling, having lost 15 to 25 feet in the past twenty-five years. For this reason many people in the country districts who use open wells have found it necessary to deepen their wells or to change from open to driven or drilled wells. There is another way in which the decline of the ground water supply can be proved, that is, by observation of the flowing wells and of water flowing to waste from the casings of old gas wells. People who are familiar with these wells know that many which were drilled years ago have now ceased to flow entirely, and almost every such well diminishes appreciably within a few years. This statement is particularly true in Madison, Delaware, Henry, Hamilton, Tipton, Grant and Howard counties, but also elsewhere. All water works engineers and superintendents know that they have to install new wells more rapidly than the population is increasing. All evidence goes to show that the ground water level is slowly subsiding.

Such a decline is not peculiar to Indiana. It was observed in the artesian well districts of Florida, where the head in certain sections along the east coast and St. Johns river has declined notably. It has also been recorded as a result of investigations by the United States Geological Survey in the Great Plains, in southern Michigan and in southern California, where the artesian basins have decreased in area, the ground water level has declined and the yield of flowing wells has diminished.

At Chicago the first flowing artesian well was drilled in 1864, and the water rose 80 feet above the surface or 111 feet above Lake Michigan. The flow has long since ceased and the head has declined until now the water stands 15 or 20 feet *below* the surface, or 100 feet lower than its original head. In the past there have been a great many flowing wells in Chicago, but the number of wells drilled is so great and the draughts upon the water-bearing strata are so heavy that now a flow can rarely be obtained.

The causes of this decline are various and differ somewhat according to locality; but in all localities certain common causes prevail which are operating to this end. In Indiana, the decline is believed to be due principally to the following factors, in the order of their probable importance:

1. Waste of water.
2. Surface drainage by ditching for cultivation.
3. Overdevelopment of underground waters.
4. Deforestation of the State.

WASTE OF ARTESIAN WATERS.

The ground water supplies have always been regarded as inexhaustible, as the nation's wealth in forests, soils, oil and gas once were, but in a very few years oil and gas fields have been entirely exhausted, soils have been worked to exhaustion by unskilled farmers and the great forests which once covered the country are now nearly gone. The need for preserving the remnants of these and other natural resources was what led President Roosevelt to call the recent conference of Governors. Water, which is the most abundant of all natural resources, is sure to become a luxury also if the present generation does not take proper precautions.

Many of the flowing well areas in Indiana have been personally visited by survey investigators, and the most conspicuous fact noticeable everywhere was the recklessness with which the best ground waters are wasted. In driving through Madison, Delaware, Henry, Hamilton, Tipton, Grant, Howard and other counties, hundreds of wells were seen from which the pure water from the Niagara limestone was flowing to waste on the surface. More than half the flowing wells in these counties were originally drilled for oil or gas. In such wells the drive pipe is sunk to the top of the limestone, and the casing inside that to the bottom of the limestone. The water rises between the drive pipe and the casing and overflows at low points along valleys or other depressions in the surrounding plain. Normally, the Niagara limestone is 200 to 500 feet thick, and the flow from it ranges from 1 to 600 gallons per minute.

In Madison County, the flowing wells are most numerous along Fall Creek, Lick Creek and White River. A conservative estimate of the number of flowing deep wells in that county is placed at 100. The usual volume of flow is probably 5 to 20 gallons per minute, but many wells yield more than this, and probably bring the average flow up to at least 20 gallons. On this assumption, the amount of water wasted every minute in Madison county alone is 2,000 gallons, making the amount wasted in a day about 1,700,000 gallons. If this were all in one place it would be ample to supply a city of 30,000 inhabitants. In some counties single wells have been seen which would supply half this number. If the conditions were distributed over the entire State the loss per unit of area would be infinitesimal in amount; but we should remember that the waste is centralized along certain valleys where flowing wells are most abundant. Moreover, this water is not derived from some distant ''inexhaustible'' source, like Lake Erie, as some have assumed, for in that case it would be necessary for the water to run up hill. Nor is there any great part of it presumably transported from the highlands in Ohio, for in that case, the high land, which only covers a portion of a single county, would soon be drained dry. On the contrary, nearly all water from deep wells in the Niagara limestone is derived from the rainfall within a few miles or even a few hundred feet of the well, where it penetrates the drift and enters the porous limestone below. When a well is drilled, if its elevation is not too great, the pressure of water in the overlying drift causes the water to reach the surface and we have a flowing well.

Water is wasted in other ways, as witnessed by the sad fact that, while 40 gallons per capita should be ample for all needs in an ordinary city without much manufacturing, most water works are furnishing several times this amount. For this evil, the meter is the remedy, as there is no logical reason why a person should not pay for the actual amount of water he uses, as he does in the case of gas or electricity. Careful investigation of city water distribution systems anywhere usually quickly converts the investigator into an earnest advocate of the meter system.

NEED FOR LEGISLATION.

A full conservation of the underground water supply is, of course, impossible, because the water is becoming more and more necessary for use. We could not and should not interfere with the right of a well owner to use the water, to the full capacity of the well, if it is all serving a useful purpose. But, for the reason that new wells are being continually drilled by parties demanding a similar supply we ought not to allow water to be wasted. Legislation should be enacted providing that all flowing wells, whether drilled for gas, oil or water, should be capped or otherwise shut off when not in use, and when in use only a stream of the requisite size should be allowed to flow. Even if the amount of water saved were infinitesimal when compared with the total underground supply, the very act of putting it to some use would be an economic gain. Where water occurs along creek bottoms below houses, rams can be installed and the water made available for domestic purposes by raising to the plains above. Or, even the formation of fish ponds or bathing pools would be an improvement on the present indifference to waste.

A number of States in this country have already realized the importance of forbidding the waste of water from wells, and California, Colorado, Nebraska, Michigan, South Dakota, and Washington have passed laws to that effect. The California act was passed and approved as long ago as 1878, and is a fair sample of what these should be. It provides:

Section 1. "Any artesian well which is not capped or furnished with such mechanical appliance as will readily and effectively arrest and prevent the flow of water from such well is hereby declared to be a public nuisance. The owner, tenant, or occupant of the land upon which such well is situated who causes, permits, or suffers such public nuisance, or suffers or permits it to remain or continue, is guilty of a misdemeanor."

Sec. 2. "Any person owning, possessing, or occupying any land upon which is situated an artesian well, who causes, suffers, or permits the water to unnecessarily flow from such well or to go to waste, is guilty of a misdemeanor."

The acts of the several other states are similar. In California the penalty is a fine of not less than ten or more than fifty dollars, together with the cost of prosecution. In Colorado the fine is not less than fifty or more than three hundred dollars, together with the cost of prosecution.

CONCLUSION.

In conclusion, it seems timely to remark that a similar law is necessary in Indiana. Another act which is necessary is to provide against stream pollution. If we allow our rivers to be polluted by sewage and by oil well and factory waste and recklessly waste our underground waters, which are the only other available supply, where is the next generation to get its supply? The writer believes that the answer to this question lies with the present generation rather than the next, and that the passage and enforcement of the needed legislation, together with the education of the people up to the proper ideals of thrift, is the solution of the problem.

SECOND SESSION.

WEDNESDAY, JULY 8, 2 P. M.

A GALLERY WATER SUPPLY.

By Howard Dill, Superintendent Water Company, Richmond, Indiana.

Where a city or town cannot secure its water supply in sufficient quantity or purity from streams or lakes, an underground source must be investigated. A careful study of the underlying strata is important, in order to determine the depth at which the water bearing vein lies, as well as its extent. The U. S. Geological Survey has done considerable work that is valuable in such investigations, and many water works would be the wiser and the richer if such sources of information had been utilized. No project of this character should be undertaken without the most thorough examination of all available data, and with the advice of a competent engineering expert. The location of a pumping station or a reservoir is largely determined by the source from which the supply is drawn, and if a mistake is made in the latter, future expense in operation may be greatly increased by required changes in the system. Smaller towns and cities, particularly, are inclined to use their own judgment in many instances, when by an expenditure of a few hundred dollars, such outlay would be returned to them from a judicious planning of their water systems.

When a sufficient volume of underground water has been located it remains to find the best means of conveying it to the pumping station. If the supply is artesian, the problem is usually a simple one. If deep wells are used, the means employed depend upon the height of the water level in the wells. If this level stands near the surface, a pipe line may be laid connecting the different wells at a point below the water level when the wells are being used. In some cases the suction pipe of the pumps may be directly connected to the wells. If the water level is at considerable depth, an air lift plant or centrifugal pumps must be considered. In case the geological conditions do not permit deep driven wells, then a study must be made of the best means of collecting the available rainfall over a certain territory. If a deep layer of gravel underlies this area, a system of infiltration galleries may be used to advantage. The rainfall passing through this gravel bed would be naturally filtered, giving in most cases a very satisfactory supply.

Infiltration galleries are used to collect water as it filters from an adjoining stream, or to catch the rainfall over a certain territory after it has passed through the gravel stratum. In both cases the amount of water secured depends upon the porosity of the sand and gravel between the gallery and the main body of water, the distance through which the water must percolate, the area of the gallery, and the head or pressure under which the infiltration is maintained.

If it is desired to use the water from a stream, it is necessary to determine how near the gallery shall be placed, and whether or not the water will filter through the intervening sand and gravel. Some streams carry a large percentage of silt, which may prevent percolation to a large degree, and many failures in the use of galleries have resulted from this condition. In some instances water has been diverted from a stream, so it will flow over a section of ground in which a gallery has been located. At first, success may result, but eventually the silt from the stream will fill the interstices in the gravel, and the same conditions exist as in an artificial sand filter.

Probably the majority of infiltration galleries in operation derive their waters from the land side, and with proper protection of the watershed, a uniformly good supply is obtained. In planning a system of this kind it must be remembered that the supply is dependent on the rainfall, and fluctuates accordingly, making it necessary to design the gallery so it will deliver the maximum flow at times of minimum rainfall.

Infiltration galleries are generally built with two or three arched rings of brick, laid in cement, resting on stone walls usually laid dry, and with a gradient depending upon local conditions. Fanning gives a number of cases of galleries in this and European countries, such as Lawrence, Lowell, and Waltham, Mass.; Providence, R. I.; Hamilton and Toronto, Canada; Binghamton, Schenectady, N. Y.; Perth, Scotland, and Angers, Lyons, and Toulouse, France.

Fanning says: "These basins generally clarify the water in a most satisfactory manner, and accomplish all that can be expected of a mechanical process, but they have not always delivered the expected volumes of water; but perhaps too much is anticipated through ignorance of the true nature of the soil and false estimate of ground water flow."

He gives the average supply per square foot of bottom area of from 150 to 200 gallons in twenty-four hours, with an average flow in the gallery of 20 to 25 lineal feet in twenty-four hours.

The supply at Richmond is derived altogether from infiltration galleries or wells.

The system was inaugurated in 1884, and the pumping station located three miles east of the city on a branch of the Whitewater River. The geological formation around Richmond is such that deep wells are not available for a supply. There are frequent outcroppings of limestone, overlaid with gravel, and small spring streams are numerous. Test wells for natural gas failed to develop water veins of any consequence below the strata of limestone. This condition necessitated the use of infiltration galleries, as the city would not permit the use of water from the above stream.

Gallery No. 1 is parallel with the stream and about twenty feet from it. It is two by three feet in section and 1,000 feet in length. No test has been made of the flow, but I believe it is capable of supplying one million gallons in twenty-four hours. A second gallery was laid in 1887, about a quarter of a mile beyond Gallery No. 1, but at a greater distance from the river. Its bottom is twelve feet below the surface, the walls are laid in stone two feet thick and three and one-half feet in height, with a distance of three feet between the walls. A two-ring brick arch is laid on top of these walls. The length of this gallery is about 500 feet. It has not given good results, and is not depended upon.

Gallery No. 3, about 1,000 feet in length, is located one mile and a half from the pumping station, to which the water is carried by a twelve-inch iron pipe. This gallery is situated from 100 to 500 feet from the stream, and furnishes about one-half million gallons a day. All of these galleries derive their supplies from the land side and very little water is received from the river side.

In 1896 an additional supply was investigated, located in a different watershed about two square miles in area. Tests showed a deep underlying stratum of gravel with the water level standing from three to five feet below the surface. Geologically, this watershed appears to be the former bed of a large river, filled with gravel. A siphon line, sixteen inches in diameter, conveys the water to the pumping station three miles distant, with a difference in elevation of 90 feet between the well and the station. The description and operation of this siphon was described in the Proceedings of the American Water Works Association for 1908, and also in a paper published in Municipal Enginering, vol. 34, p. 340. Approximate estimates show this watershed to have a daily capacity of two million gallons. At present from 750,000 to 1,000,000 gallons are utilized. It is a water of unusual purity and clearness, with a temperature of 52 degrees at the well in summer.

From the receiving well at the pumping station the water is pumped to the city or to the reservoir. The latter originally had bouldered sides and clay bottom. About 1898 a disagreeable taste was noticed, and traced to the reservoir, where small growths of algae occurred. These were removed in winter by emptying the reservoir and allowing the mud to freeze. In 1903 this condition became so bad, the algae covering the entire bottom, that it was decided to cement the bottom. This remedied the trouble for a few years, but the taste again became disagreeable. Consultation with the Department of Agriculture at Washington resulted in recommendation of the use of copper sulphate. This was tried with only temporary relief. In 1906 the company engaged Dr. Geo. T. Moore to investigate the situation. His report showed the trouble to be in the mud between the boulders of the reservoir, the copper sulphate not destroying the roots of the chara. In his report Dr. Moore recommended the use of 100 pound doses of copper sulphate, or the lining with cement of the bouldered sides. Two applications were made within the next year, but with only temporary success. In 1907 the company concluded to resort to cement as a means of removing this annoyance. The work was completed in November, 1907, and very little, if any, taste is now apparent. The twenty-inch inlet and outlet pipe of the reservoir is situated in one corner. By means of two check valves and a twelve-inch line laid to the opposite corner, a better circulation was secured. The total cost of the work in 1903 and 1907 amounted to $15,000, and is considered a good investment. At the time of Dr. Moore's investigation in 1906, he also found evidences of crenothrix in the siphon well. Several applications of copper sulphate have been made in this well, and it is believed this trouble will be removed in a short time.

In all this work the advice and approval of the State Board of Health has been sought, and the company has always endeavored to comply with its recommendations, realizing that such co-operation benefits the company as well as the consumers which it supplies. No case of typhoid, so far as I know, has ever been traced to the water furnished, and from a commercial standpoint the company considers it to its interests to maintain its product at the highest possible standard.

A FILTRATION SYSTEM FOR SMALL CITIES.

By F. W. Witherell, Water Works Engineer, Pittsburg, Pa.

One of the problems which you will have to take up in this State is that of purifying the water supplies. You cannot expect to obtain water supplies pure from a chemical standpoint for your deep well supplies are generally quite hard, and your river supplies are more or less polluted by sewage or manufacturing refuse. You are now having the same water supply problems that came up in England, perhaps forty or fifty years ago. About twenty-five years ago, in Massachusetts, some of these same problems came up and today in Pennsylvania and Ohio steps are being taken to improve a great many of the water supplies. Of course, you all realize that within the past ten or fifteen years the general public has demanded a better quality of water supply and I think that is generally true all over this country. People who, ten or fifteen years ago, would be satisfied with a heavily colored water or a turbid water or even a water more or less polluted with sewage, will not drink that water now, except when they do not know anything about what the supply is. The general public is becoming better informed, better educated and in a good many cases is becoming rather afraid of the public water supplies of the central states. In fact, I suppose at the present time more people are using bottled waters than almost any time before this. The three classes of waters which generally have to be improved or purified, and which we find in this State are the deep well waters, what might be termed the shallow wells, and the surface waters. Many of our well waters in this State, as you know, are gradually deteriorating. I do not mean by that that they are polluted, but as the ground water supply is drawn upon, the ground water is lowering, and, I think, in many cases is growing harder. The sulphate of lime is increasing and in a good many cases the amount of lime is increasing so much that it is causing a great deal of trouble. In some of our oil fields the deep well waters have been polluted to a certain extent by salt water, and in a number of cases the hard drawing upon the public supplies has increased the chlorine in the public water supplies. In this State, in Ohio, Missouri, and I think in Illinois, water softening plants have been installed, which take out the large amount of carbonate of iron in public water supplies. At Muncie, Ind., at the present time, the public water supply is treated and practically all of the iron is removed. Generally, waters from cribs are good, if in gravel foundations, and are quite satisfactory if not drawn upon too hard. I have known of a good many instances, in Massachusetts and in Pennsylvania, where these water supplies from cribs and shallow wells, have been drawn upon too hard, and the supplies permanently ruined. Even the crib, when drawn upon very hard will furnish an inferior water supply, and if the river near the crib is badly polluted, the water from the crib may be permanently polluted. One case I have in mind that might interest you. A small town in Pennsylvania, about fifteen years ago, took its water from the Ohio River. The city officials decided to put in a crib and a few wells in the gravel in the bottom of the Ohio River. They immediately obtained a fairly good, but very hard water supply, which contained considerable carbonate of iron. But the town is growing and the water supply has been increased. The water consumption is increased so that probably four times as much water is drawn from that crib as was about eight years ago. In the vicinity of this town, perhaps one-half mile above, several oil wells have been opened, but not properly plugged, and water has been flowing out of them. In the last year the crib supply has been permanently ruined. Probably, if they had not drawn so hard upon that crib supply they would still have had the hard water, but at the present time the water is ruined and cannot be improved. Several cities on the Ohio River have cribs and draw a small amount of water for domestic purposes, but in almost every case where the experiment has been tried of constructing large cribs or large filtration galleries, the water supply is somewhat diminished on account of the heavy draught. One private company, supplying about 50,000 people, near Pittsburg, has put in four filter cribs, each one, I think, about 400x100 feet, and now they may put in the fifth, as their consumption has increased. They have drawn very hard upon these cribs and they have proved quite unreliable. In fact, about two years ago, one of them broke during a freshet and caused an epidemic of 400 cases of typhoid faver.

In taking up the question of the purification of surface waters, we have a good many things to consider. In this State you have principally sewage and suspended matter. These will probably give you the most trouble. You also have the drainage from manufacturing plants, the wastes from oil wells, but I do not know that you have any serious troubles with color. A great many of the public water supplies in the states where there is a large amount of forest and marsh are heavily colored. In some parts of Wisconsin, Michigan, New York, Massachusetts and Pennsylvania, and some of the eastern seacoast states, the water supplies are very heavily colored, and people now will not drink these water supplies, although they would ten or fifteen years ago. In some of the western states, principally along the Mississippi, Missouri, Illinois and Arkansas rivers, the amount of suspended matters in river waters is very high and causes a great deal of trouble in the purification of water supplies. The Ohio River and the rivers in this district are not so bad. Probably the most dangerous pollution that you have in Indiana is the sewage pollution.

In the purification of public water supplies, there are two types of filter plants which are being used extensively. The slow sand type, by which water is passed slowly through a bed of sand, and the rapid sand filtration type, in which the water is first coagulated with a chemical and artificial coagulant, which forms a jelly, put into the water before filtration. In the slow filtration type this jelly is formed entirely by low plant forms. In this State today we have both types of water filtration plants, and both types apparently are doing very good work. The slow filtration plant is best fitted for water supplies that are quite badly polluted, which are colorless and which have a high turbidity. It is also best fitted for water supplies which are free from algae growths. The mechanical or rapid filtration plant has probably been most successful in taking care of the waters that are high in suspended matter, high in color and not heavily polluted. However, several experiments have been made in the last few years by using a double system of rapid sand filtration, with very heavily polluted water. These experiments have shown that the double filtration by a mechanical filter plant will furnish a water supply which is practically sterile and is as good as the very best water which can be obtained by the slow sand filtration plant. A new process of water purification known as the ozone process is being experimented with at the present time. In the future we may be able to purify our polluted water supplies by filtration and then use the ozone treatment as a final process, practically sterilizing the water.

In a good many cases water departments and water companies have complained about the cost of water filtration plants, and have actually stated that they could not afford to improve their water supplies so they would be safe and potable. I think that has been demonstrated to be not true, as quite a number of water departments and water companies have found that by putting in water filtration plants and improving their water supplies so they are above suspicion, in the course of a few years the revenues have increased more than enough to take care of the operating expenses of water filtration plants. In a few of our cities improvements in water supplies and installation of water filtration plants, have not improved the sanitary conditions as much as was expected, but in many cases the improvement of water supplies have resulted in a decided improvement as far as typhoid epidemics and other intestinal troubles have been noticed. In one city in western Pennsylvania, with which I am familiar, the typhoid rate, about five or six years ago, was about 150 deaths per year per 100,000 population, but after the installation and operation of a rapid sand water filtration plant, the typhoid rate dropped down to about 15 or 20 deaths per 100,000 population a year. That is about 90 per cent. reduction and is about as good as could be expected in a manufacturing town in Pennsylvania. Also in that same time there has been quite a decrease in the number of cases of intestinal diseases, and I believe the total death rate has been slightly lowered. In a number of other cities, water filtration plants have been a decided help in the prevention of epidemics. For instance, at Butler, Pa., where there were about 1,500 cases of typhoid fever and about 100 deaths in the fall of 1902, the shutting down of water filtration for a few days probably caused a polluted supply to be sent to the town. In Scranton, Pa., about a year ago, there were about 1,500 cases of typhoid fever and if that water supply had been properly taken care of, filtration plants put in and the watersheds properly managed, there probably would have been no typhoid fever. In several cases I have investigated epidemics caused by suddenly polluted water supplies. About a year and a half ago, the water supply of a city on the Allegany River became suddenly contaminated through sewers. Within four days there were over 1,000 cases of gastro enteritis. A good many people were very ill, but no cases of true typhoid developed. That all of the sewage from this case went down the Alleghany River was plain, for about two days later it reached a town about fifty miles above Pittsburg. At this town there were in the next four or five days probably 4,000 cases of gastro enteritis, and following that a hundred cases of typhoid fever. There was a mechanical filter at this town, but unfortunately the people operating the water works did not know how to use it, and they washed their filters with dirty river water, and so the filter plant was no protection. I came to this city shortly after this epidemic had commenced, and we started coagulating the river water and washing the filters as they should be washed. The epidemic dropped off almost immediately, as the water supply was satisfactory. In the second city it was clearly a case of waterborne disease, which could have been prevented by a sewage disposal plant at the upper city or a well operated water filtration plant at the lower. In many cases where water supplies are continually badly polluted, typhoid fever is endemic and, to a certain extent, many of the population are immune, but if the supply is improved, the greater mass of people gradually seem to lose that immunity, so that if anything ever happens there is likely to be a great number of cases of typhoid fever or some other intestinal trouble. We can not expect to find our rivers or surface streams unpolluted, but in many cases we can make the best of them, and, although we carefully purify our river waters, I still believe we should purify and dispose of our sewage as well. We are not certain that the present water purification, which seems to give good results, is perfectly satisfactory, and although many engineers advocate only water filtration, and when necessary, double filtration, yet I believe the sewage from our towns should be purified before it gets into our streams, and to me it seems that the careful purification of sewage is just as important as water purification.

SALT WATER AND OIL IN PUBLIC WATER SUPPLIES.

By Quince Walling, Superintendent Water Company, Muncie, Ind.

The main pumping plant of the Muncie Water Works Company is located two and a half miles east of the city, on the banks of White River. Our supply, at the time this subject will refer to, was taken from deep wells and White River, using the river in case of fires and at times when the consumption ran beyond the capacity of the wells.

In order to show you that the water company had taken all the precaution that any one could, under ordinary conditions, I will read a few extracts from a report made to the city of Muncie by Charles Carroll Brown, employed by the city in the year 1897 to make a report on conditions of our plant. His report on White River for a water supply is as follows: ''The sanitary condition of the river water is unusually good. The condition of drainage and the small amount of pollution entering the river above Muncie make the water a good potable water, if proper steps are taken to filter it and remove the organic and inorganic matter contained in it when the rains wash the soil into the river. For many purposes the river water is better than well water.''

I want to add to Mr. Brown's report that at this time White River was one of the most beautiful small streams of water that I ever looked at. Its source is about 22 miles east of Muncie and with no sewerage coming into it from cities. It is fed by springs from one mile east of us the entire distance, first being the famous Inlow Springs and the Rees Springs and many more that I could mention, making a nice, clean, clear water, running over gravel and lime rock, a supply that no good engineer would hesitate to recommend for a water supply for any city.

In the year 1889 we found that our well water supply began to fail and the water company decided that we would put in some more wells. Accordingly six additional wells were added to the twelve that were already in. Our wells are located along the banks of White River, covering a distance of a little over 7,000 feet. To these wells we have attached one 12-inch and one 14-inch suction line laid in the river, running to what we call our receiving well. This is built of brick 25 feet in diameter and 40 feet deep. Into this well we drop our suction lines about 30 feet and attach to them a vacuum pump and siphon the water from wells into the receiving well and from here we pump direct to the city. In doing this work in this way, we were compelled to lower our pumping machinery down in pits about 14 feet, so that the suction lift would not be too much. This increased our supply considerably and we were much pleased with results, but our city was growing very fast, and knowing in our own minds that we would soon be in trouble again, as to supply, we decided to put in a filter plant so that there would be no danger of shortage any more. This was completed in 1900 and the water company congratulated themselves on having the water supply question solved for all time to come, as far as Muncie was concerned, that all that would ever be needed would just be additional filter capacity. But even water works people get fooled once in awhile.

Along in 1902 oil was discovered in the Delaware County field, on what was known as the Daniel Boone lease, located two miles east of our water plant. Every one went wild; all the land from the city limits to the edge of Randolph county was leased. Oil companies were organized, and it seemed to me that everyone of them thought the oil was all along White River. In the short space of eighteen months there were over 600 oil wells dumping their salt water and refuse oil into White River, ruining the stream and making it unfit for use of any kind. Here we were, with our money invested in a filter plant and no water to use in it except White River. The chlorine tests made after oil developments were started, showed from 500 to 1,100 parts per million, while under normal conditions it was from 40 to 100 parts per million. With these comparisons you can draw your own conclusions as to whether the water had a brackish taste or not. The oil would come down past our plant in patches fifty feet square, and I have seen the river covered for half a mile with this dirty black oil. It was not a hard matter to get rid of this, as we had arranged some timbers on our dam so that the current of water could be changed and allow this to go on down stream for Indianapolis and Anderson to handle; but when the salt water got thoroughly mixed, this was the sticker; stock would not drink it, and it killed the fish by the thousands. At one time there was by actual measurements, and this was not all, over three million gallons of salt water going into White River, from our plant up the river to Smithfield, a distance of four miles. From the experience that others had had, we figured that we could handle it all right, but conditions were different. As I understand it, these other fields did not have the salt water to contend with. We thought that with as little water as we were using from the river and mixing it with the well water, the taste would not be so bad. So we kept up the filtration, pumping from a gallery connected to the river, and found at times we would get some bad water. Then we constructed a large steel tank, put it up high enough that the water would flow to filters by gravity. On this we piped the water to the top and let it flow out over the sides of the pipe in thin sheets, dropping it on a screen with one-quarter-inch mesh, forcing the water to drop on bottom of tank the same as rain, giving it good aeration. We still got some bad tasting and smelling water. Then we tried aeration after filtration, by constructing a wooden frame four feet square and ten feet long. In this we placed four screens of different six mesh wire—one-fourth inch and smaller—attached this to the outlet pipe of filters and made the water go into receiving well in a regular shower, striking a ten-foot platform before mixing with the well water. This did fairly well and we were getting along in fairly good shape, but the citizens were complaining some and not being satisfied we decided to try out the air lift. So one was installed on the wells at the plant. After spending some $12,000, we found that we were geting no better results than with our siphon system. But the air lift was our undoing. One warm Sunday in July we were running along, thinking everything was all right, when the compressor let go, burst heads out and tore the machine up in general and then we were up against the real thing. For a few days we were forced to furnish river water alone to the city—the memories are not pleasant. The newspapers went after us rough shod—no one had a good word for us. Our domestic consumers were getting water for drinking purposes wherever they could. The steam users were trying to sell us salt that they had collected from small leaks on their boilers. The city council, board of works and Commercial club took up the cause and used the big roller just as hard and as often as they pleased—every one had their turn at us. The Commercial club even got Dr. J. N. Hurty, of the State Board of Health, to come to our city and investigate the situation and to address the citizens on the evening of his visit, after going over the plant and seeing the condition of White River.

I will give you a few extracts from Dr. Hurty's talk: "We Americans are so used to hanging on by our eyebrows that we don't shudder any more. Muncie is in a precarious condition at present from her water supply—that much has been revealed to me today. Germs and impurities of all description may be removed by filtration, but the taste of salt and oil, be the filtration process ever so perfect, can not be eradicated until their presence in the stream is no more. Deep wells will solve the problem, as it is the only available supply at this time." The latter remark of Dr. Hurty is where I took exceptions. We had at this time information enough on the deep well question to fill a small book. On our own system we had 18 of the best wells in Delaware county, covering a distance of 7,000 feet from our pumps and affecting all the wells within one and a half miles of them, and it was not practicable to go any farther. We also had information in regard to the other wells over the city, supplying our manufacturing concerns, that they were not getting out of all of these wells combined over 750,000 gallons of water per day of twenty-four hours. When the head of ground water falls from six feet above the surface to thirty feet below it makes one feel as though the water supply question was getting serious.

This was not all of our trouble. At this time we found that the farmers had begun to complain about the oil companies allowing the salt water to run over their farms and into the tile ditches, ruining the land and clogging ditches. So the oil companies piped the salt water back to the oil well and allowed it to flow into the fesh water between the drive pipe and casing. Our wells, by the tests we made at this time, went from 40 parts per million normal, up as high as 150 parts per million. At this you could not taste the salt, but it began to look serious, with no law to protect any supply. It did not look very encouraging for us. Even had it not been known that this condition existed, it seems to me that for the benefit of the general public, too much can not be done to protect the water supplies of the State of Indiana.

While we were working and investigating all this time for a good supply of water, feeling that for our own interests as well as the public, the Board of Works of our city and the Water Company, came to an agreement that we should build an auxiliary pumping station three and one-half miles away on Buck Creek, a tributary to White River drawing some 35 miles of area lying south of the city. This station with pipe lines was completed in October, 1905. Since that time the public water supply has consisted of deep well water, supplemented by such amounts of filtered Buck Creek water, as are necessary. We have in all nine mechanical filters with a capacity of a little over five million gallons per day. The water from Buck Creek plant is pumped to No. 1 plant through two 12-inch cast-iron lines into a settling tank 50 feet in diameter and 20 feet deep, and from here passes through the six concrete filters into the one million gallon concrete reservoir. The well water is all filtered, passing through the iron filters, getting rid of the iron entirely. From here this also goes into the reservoir, well water and creek water being mixed and so pumped direct from here to city.

From the reports that we get from the State Board of Health and our own investigations, we feel now that we are in shape to give to the citizens of our city, a good, pure and wholesome supply of water. After what we have gone through with, gentlemen, I am most thoroughly convinced that the water supply of the State of Indiana should be given every attention that is possible. The work has started—keep it up. In case you are so unfortunate as to have your present supply ruined by salt water and oil, begin to investigate all the available supplies in your territory as it means a new supply or no business.

METHODS OF WATER ANALYSIS.

By J. Herbert Brewster, Water Chemist, State Laboratory of Hygiene.

A familiar adage that has been handed down for many generations is "Running water will purify itself." While it is true that many people have undoubtedly been saved severe illness by this action, yet from a technical standpoint the old saying is a fallacy. It is not because the water runs that it is purified, but it is because there has been a lapse of time between the source of pollution and the place where the water is considered wholesome. In this time the matter in suspension has had an opportunity to settle and the bacterial count will be found to be much less, not only for the same reason but also from the natural rapid death in water. The length of time required for running water to be purified varies inversely as the velocity of the stream inasmuch as it is a proven fact that a perfectly quiet body of water will purify itself much more rapidly than a running stream.

In much the same manner is there a grave misconception regarding the analysis of water. It is the general idea that a sample of water may be collected in any manner, be shipped in any kind of a stoppered vessel, and there will be returned an opinion as to its suitability for potable uses, while at the same time all information regarding the source of the supply and the local surroundings where the sample was taken, is not only unfurnished but is intentionally withheld for the purpose of having the desired report unprejudiced in character.

Even if a suitable analysis could be made from a sample taken in this way, the result could not be returned without a complete history of the sample. For instance a surface water that contained high amounts of chlorine as well as high nitrogen contents would from these factors alone be condemned, while on the other hand an artesian well water with exactly the same contents would be capable of an explanation other than surface infiltration. For example, a mountain stream of rain water should contain but slight traces of chlorine while a deep well at Syracuse, N. Y., would be expected to contain large amounts of chlorine.

Then again should a water at some previous period be unwholesome, the lapse of time and the underground filtration between the point of pollution and the cropping out of the water would render it a potable supply. The chemical constituents have not been changed, yet it can be readily seen that their presence is not detrimental to the water.

The analysis of water is far different from the analysis of a mineralized rock in which the constituents are valuable of themselves. For instance, limestone is valuable as to the amount of calcium it contains, a piece of Hematite on the amount of metallic iron, and a gold ore on the amount of precious metal that can be extracted. With the sanitation of water this is not so. The constituents contained therein are only valuable for what they indicate.

The chemical analysis of water is simply a series of experiments which determine directly or indirectly the amount of organic matter present and the nitrification products carried both in solution and in suspension. These experiments simply aid the judgment of the analyst in determining the potability of the supply and have no significant value of their own. The methods under which these experiments are conducted differ greatly inasmuch as each analyst has his own ideas as to the scheme that should be carried out, making it utterly impossible at times for one set of results to be compared with those of another laboratory. Then again it often happens that the analyses are of a comparative nature such as those of filtered and unfiltered water in a purification plant. It may also be desired to see the effect of verticle currents in lake water, in which case it is a comparison of different samples taken at the same place and the same depth. Suppose one is desirous of knowing whether or not the water of a large stream is polluted by upstream sewage. In this case samples must be taken from above the point of pollution and compared with an analysis of the water at the point in question. If it is found that a change has taken place due to the addition of sewage the water should be condemned no matter how closely it compares with the erroneous ideas of organic purity. For these reasons it is absolutely essential that the analyst have all possible information furnished him. Then by a careful study of the entire situation the quality of the water may be accurately determined.

It very frequently becomes the duty of the analyst to answer the question: What can we take as an analytical standard for determining when a water is suitable for drinking and domestic purposes? The city fathers are extremely anxious to have a set of figures that they can put down in black and white on the renewal of a contract with their local water company. The water company is also desirous of a standard in order that they can easily live up to the terms of their contract and the health officer, who has many different styles of analyses presented to him for interpretation, would also like some definite form to go by.

The speaker has had several requests to disclose at this time the standard by which the State Board of Health determines the purity of a water supply, that it may be adopted by companies and corporations both private and municipal so that they can say in times of difficulty, ''we will submit ourselves to the State as authority.''

Permit me to say that the standard is just this: *That the water shall be safe and wholesome,* nothing more. A set of figures as a standard in any case is absolutely valueless. There are three distinct divisions in the analysis; one is a careful and thorough sanitary survey, second a chemical analysis and third a bacteriological examination. All of these have their importance, and no two give you a complete knowledge of the situation.

With these data at hand, it now rests with the good judgment of the analyst to determine whether or not it is a potable water. Of course the presence of bacteria of the colon type is in itself a condemning feature, and high bacterial counts are not desired. If there is a larger amount of chlorine present together with nitrogen in the form of nitrates it is quite conclusive of past pollution; high nitrogen in the form of nitrites is a bad indication; and the presence of albuminoid ammonia is quite indicative of undecomposed organic matter.

By a sanitary survey we mean that the analyst actually goes on the ground and gets a knowledge of the source of the water and of the opportunities for pollution, both constant and occasional, to which it may be exposed. He then looks into the rock stratum and sees if the cleavage and cracks runs from the points of pollution toward the water or away from it. He determines the nature of the soil in which the water is located and together with numerous other points that he discovers, he is greatly aided in determining the safety of the water, but it is very essential that he know these things to make it possible for him properly to interpret the analysis. In my judgment it is not too much to say that if but one form of examination be possible, the sanitary survey should be selected. But although, taken alone, I believe the sanitary survey in the majority of cases is the most important form of examination, I beg not to be misunderstood, for no amount of inspection could be substituted for the bacterial count in testing the efficiency of a filter plant.

Not only is this examination of the water the most important, but it is positively an essential and no company should attempt to operate a filter plant without a complete knowledge of what they are supplying their consumers. It should be from a bacterial examination that the coagulant of a mechanical filter is increased and decreased, instead of relying wholly upon the turbidity and color that is in the water. Merely clarifying a water and producing an excellent appearance means absolutely nothing, for it is not the things that you can see in water that are harmful, but it is things that you cannot see, and this very point is the strongest one why the operation of a plant should be entirely under laboratory control. The public place their confidence in the water company to produce a safe and wholesome water, and as long as the water has a good appearance and a good taste there is no complaint to be made, but if the water company simply strains a water and allows a gross amount of the pollution to stay in the water, they are not only disregarding their contract but they are endangering the health of the people to whom they deliver the water. If laboratory control is not maintained the beds may foul and become breeding grounds for disease-carrying bacteria. It has actually happened that where beds have fouled, the filtered water has contained more bacteria than the unfiltered and B. coli has been present, when they were absent in the raw water. Yet this condition could not be detected from the appearance. Not only is the operator working in the dark, but the unsuspecting public are innocently drinking a heavily polluted water, and public health is of entirely too much importance to be subjected to any such risk.

It has been shown that the sanitary survey is needed and that the bacteriological analysis has a place of most importance, but it is none the less true that there are times when both of these are of little value and the chemical analysis is the one to be relied upon. It often happens that a well is so situated that the surroundings are of the best and it is not possible to determine the source of the supply. The bacterial analysis may show good results for the reason that the land lying between the source of pollution and the well is at the time of examination, filtering the water. But during a rainy season the land becomes over-burdened and unfiltered sewage enters the well. Both the sanitary survey and bacterial examination fail to show danger, but the chemical analysis plainly indicates that the well is receiving sewage drainage. At all times is a single chemical analysis of water of much more value than a single bacteriological. In drawing a conclusion it is readily seen that each has its place and that in the majority of cases each is dependent upon the other.

As there are many methods for doing both chemical and bacteriological work and also different ways of reporting the same, it has been thought advisable to, at this time, propose a scheme of analysis which if adopted by all who do chemical and bacterial water work, will make a uniform system that will enable one laboratory to interpret and compare work with another.

The purpose of this paper is not to lay down a rule that everyone must follow whether they desire to do so or not, but is simply to put before you a complete scheme which will be open for discussion and any ideas will be changed that are thought advisable by those present. It is simply to try and make a uniform system throughout the State.

It may seem to some that you will have to change your work considerably, but I will assure you that it will not affect anyone any more than it will the State Board of Health.

The book to be used as a guide will be ''Standard Methods of Water Analysis,'' adopted by the American Public Health Association.

Results of chemical analysis shall be expressed in parts per million. In collecting samples one-gallon ground-glass-stoppered bottles shall be used for the chemical analysis and two-ounce ground-glass-stoppered bottles for bacteriological samples.

The turbidity shall be done by the silica method adopted by the United States Geological Survey.

The color shall be measured by the platinum-cobalt method.

The odor should always be noticed.

The nitrogen shall be determined as free ammonia, albuminoid ammonia, nitrites and nitrates in the ordinary methods.

The total and fixed solids should be determined.

The iron shall be determined by the use of potassium permanganate for oxidation, and potassium sulpho-cyanide.

The alkalinity shall be determined, making your own choice of indicators, lacmoid erythrosine or methyl orange being entirely satisfactory, except that methyl orange cannot be used in handling the effluent of a mechanical filter where alum is used as a coagulant, as it does not indicate acidity due to alum.

Chlorine shall be determined by the chromate method with nitrate of silver. If Volhard's process is desired in case of high chlorine there is no objection, but it is not advisable where the chlorine contents are low.

With the present knowledge of bacteriology there is no method known by which the absolute number of living bacteria in a sample of water can be determined, and all quantitative determinations of bacteria are necessarily of a relative character. This being the case, strict adherence to a standard procedure is of especial importance. The standard medium for determining the number of bacteria shall be nutrient gelatine to be made as described in ''Standard Methods,'' with the exception that beef extract may be substituted for lean meat. The procedure to be followed is also carefully given. Incubation shall be 48 hours at 20 degrees centigrade. If the cultures be incubated for more than 48 hours the time of incubation should always be stated in the reports. The problem of comparing the results of two laboratories as to bacteria is undoubtedly the most difficult problem in water analysis and for this reason it is very essential that a standard medium be used, that a temperature of 20 degrees C. be kept as nearly as possible and that the number of hours of incubation be the same in all cases.

The test for bacillus coli is of great importance and shall always be made.

This system of analysis, completely carried out by all laboratories in the State, will remove many of the difficulties that arise from the different methods now in use and will also aid greatly in obtaining a complete knowledge of the water throughout the State of Indiana.

THIRD SESSION.

Thursday, July 9, 10 a. m.

A. H. Kennedy, President Rockport Water Company, read a paper on "Water Supplies of Small Cities in Southern Indiana."

It has not been possible to obtain Mr. Kennedy's paper and we therefore print only a brief abstract taken from notes made at the time of the address. Mr. Kennedy called attention to the new method of purifying water by saturating it with ozone and exhibited a drawing illustrating a satisfactory method of introducing the ozone. One great difficulty with the water plants of Indiana is caused by the filling up of the suction pipes which go to the bottom of the rivers and suck up mud and sand instead of water. At Evansville the pump valves have to be renewed frequently because they are so badly cut by the sand. The proper way to operate is to build an intake of concrete at the side of the river into which the suction pipe enters.

Indiana needs a law providing for a public utility commission like the one in Massachusetts and New York. This commission is composed of a number of experts to which all questions relating to the management of water-works, franchises, water rates, taxes, etc., are submitted and to which everyone may appeal when in trouble.

Water-works corporations and companies pay in taxes five per cent. of their income. The company at Princeton pays six per cent.; other companies pay 1 per cent. of their income in taxes. There should not be such a wide variation. The Public Utility Commission would gather accurate statistics; determine the gross income of every city in the State and the gross taxes. These taxes and incomes would be added together and the gross taxes divided by the gross income to get the rate paid on the income. If this figure is three per cent. then the Board of Review or the assessor would investigate those companies paying less while those paying more would get a more equitable rate.

The great difference in hydrant rentals can only be equitably adjujsted by having actual statistics compiled to establish the rate for the entire State. Water-works are up against the tax proposition. Five per cent. of the annual income is an exorbitant charge.

DISCUSSION.

L. C. Boyd: We pay 7¼ per cent. of our gross receipts as taxes.

Dow R. Gwinn: We beat that; we pay 8½ per cent., but then we are easy; as a matter of fact, when it comes to assessing water-works property, the company is at the mercy of the assessor; the average citizen does not begin to pay taxes upon the value of his property; but the water-works is something that they can get hold of; I don't know any way out of it; the assessors have a meeting at the court house, state so much, and we have to pay it.

L. C. Boyd: Do you raise rates accordingly?

Dow R. Gwinn: I guess not; the better the quality of water, the less money for it, if the average council has its way. I am very glad to have Mr. Kennedy bring up the Public Utility question. The plan is to get, I should say, a favorable Utility Commission bill —fair not only to the State, but to the people at large; and when we get a commission appointed by the State the affairs of water-works companies, at least, will be taken out of local politics (that is something to be brought about) and not be subject to the councilman, who may be a bartender, a drygoods merchant or a grafter, who will hold up and get all they can. The main point is that water-works companies would be sure of their investments; as the matter stands now, in most states, a water-works investment is subject to a sale at any time by local politicians; if rates are not satisfactory, they will put in another plant.

The U. S. Federal Court decided recently that the water company has no right to the streets and must remove their pipes from the street in Sioux Falls. That is the worst case I have ever heard of; they must remove their property from the streets because the privilege extended only for the time of the franchise. I hope Indiana will have some such bill as is now introduced in Wisconsin.

TRANSMISSION OF TYPHOID FEVER.

By H. E. Jordan, Bacteriological Chemist Indianapolis Water Company.

There may be a question in the minds of some present as to the appropriateness of the discussion of the causation of typhoid fever at a water-works meeting; but when it is taken into account that in the minds of the vast majority of people and the great number who have written regarding the disease in the past few years, water has been assigned as the sole cause of typhoid fever, it becomes evident that the discussion of the merits of this matter are worth while in this place. It was as late as June, 1906, that Samuel Hopkins Adams, in McClure's Magazine, made the statement that all typhoid is directly caused by the agency of water, and Dr. Wood Hutchinson, in the spring of this year, stated that 85 per cent of typhoid is water-borne. Beginning, however, with the studies of Sedgwick and Winslow in 1902, and following the operation of the Washington Filtration Plant in the studies that have resulted from the question raised there, there has been a growing opinion that the liability for typhoid fever has been mis-emphasized to a large degree, and although there are a number of instances in the past where polluted water supplies have been responsible for epidemics, the steady development of the disease is apparently due to a number of factors. Whatever may be the greatest causative agent of typhoid, it is without question true that its prevalence is too great for sanitarians to accept as necessary. It is worth while to consider for a moment the cost of typhoid fever in order to get the importance of its prevention well fixed in mind. It is a recognized fact that the greater majority of those who die from this cause are between the ages of 20 and 35. Basing one's estimate upon the value of human life as given in insurance estimates, the average value in life capital that is thus destroyed, is about $5,000.

In the summer of 1907, there were studied in the 7th and 9th wards of Pittsburg, 194 cases, with especial reference to the actual cost in money expended. These cases occurred in 149 families; from them there were 11 deaths; 87 wage-earners lost 964 weeks' work; care-takers (not professional nurses, but members of the family) lost 182 weeks' work; there were 13 of the cases treated in hospitals—total cost, in these three factors alone, of $24,300. This being proportioned among the 194 cases amounts to $125 per case, or $2,200 per death. It is without question that the cost more nearly approximates $2,500 per typhoid death on account of the inability of the patient to resume work at his normal rate. This makes a total cost per death of $7,500. There is, then, with the sole question of money cost in mind, a very deep problem for solution before this one cause of destruction of human life is eliminated.

Typhoid is characteristically a disease of modern civilization, and, in fact, it is apparently not present among uncivilized people. Only as short a time ago as 1830, it was just beginning to be recognized as different from typhus or spotted fever (which, by the way, has within the last few years practically disappeared), but it was not until 1850 that it was understood as an individual and characteristic ailment. The development of knowledge regarding bacterial agency in disease causation, along in the early eighties, brought with it in 1884 the discovery of the Bacillus typhosus, which is now recognized as the direct causative agent of typhoid fever. For many years the opinion was held that the fever was directly caused by breathing swamp air or living in damp places. There was, further, the theory advanced by certain French doctors that certain fermentative conditions in the body were responsible for a breaking down of the natural defenses and the onset of the disease.

With the development of modern sanitary science it has become understood that there are three determining factors necessary to a case of typhoid—the existence of an infective agent, the germ; a suitable channel for the transmission of the germ to a susceptible individual; and such a condition of vital resistance on the part of an individual as will permit the development of the organism in his body. The first factor—the existence of the germ—has a necessary corollary; no case of typhoid is spontaneous; each is dependent for its existence upon the failure of some previous patient and the attendants to destroy the germs cast off by that person. The escape into the outer world of B. typhosus from one case is the necessary antecedent of every other case.

It has been demonstrated, within the last few years, that the blood of a person infected with typhoid is filled with typhoid bacilli for a number of days before the patient becomes ill. This has led some to believe that typhoid bacilli may escape through the pores of the skin. Except in cases where typhoid is combined with pneumonia, it is not probable that the coughing of a patient will allow any of the organisms to escape through the mouth. During the period of the fever, and for a time afterward, the excrement of the patient is highly charged with typhoid bacilli, and for six or nine months afterwards the urine is also highly charged.

One of the most important discoveries in the study of typhoid in recent years is that persons who have had the disease may not only void the infection during this period, but by the germs becoming seated in some organ of the body, the gall bladder or the bladder, although to all outward appearances perfectly well, may continually be giving forth typhoid bacteria, and this condition may continue, not only for a short time, but for years—it is known to have occurred for seven years in the case of the cook at Oyster Bay, Long Island, who infected 27 persons in that time and caused two deaths from the disease. It is by these means that the great spread of typhoid organisms is accomplished, and the step which must be taken to prevent further cases of typhoid is the disinfection of all slops from the patient and the disinfection or burning of all cloths and utensils used in the sick room. The importance of this cannot be overstated, because it is in this one point that rests all future cases of typhoid fever. There is no question that if for one year all cases of typhoid were treated in this manner, the disease would disappear, and it is simply through the failure to take this precaution that the majority of cases of typhoid are undoubtedly responsible for later ones.

I wish you could get this clearly in mind, that just as if I should level a loaded revolver at this audience and pull the trigger, the bullet speeding from it might strike, injure and cause the death of some of you—so the improperly cared for typhoid patient may give forth infected matter that may strike, sicken and cause your death.

Unlike lock-jaw or bubonic plague, the entry of this organism into the human body does not occur through any lesion of the skin, nor is there any particular reason to believe that, like tuberculosis, it is spread through the medium of the air and wind. The entry of the typhoid organism into the body must be through the mouth, either with food or drink, or by touching some infected medium to the lips. The time elapsing between infection and the noticeable onset of the disease is from eight to ten days. The seat of the disease, as generally understood, is in the small intestine, and consists mainly in the lodgment of the organism in the "Peyer's patches," as they are called, the production of an inflammation and ulceration, accompanied by high fever and, in extreme cases, the perforation of the intestine, which is accompanied ordinarily by peritonitis.

An investigation of the typhoid cases in Indianapolis in 1904, discloses the fact that in the great majority of cases there were no attempts whatever at disinfection of slops, and, in fact, there had been no advice on the part of the attending physicians that such a thing should be done. There is no question that the medical profession is largely responsible for the failure to comply with this necessary step, and not until it is recognized by them that this is necessary will the steps which have been taken by the Boards of Health, or those who are concerned in the public supplies of food and drink, be effective.

Keeping in mind, then, the fact that Bacillus typhosus is responsible for typhoid, and it is through the failure of persons attending the patients properly to disinfect the slops that the organism escapes into the outside world, it becomes a matter of importance to know how long it will live outside the human body. Our interest is necessarily directed to things that may themselves, or by their contamination of other things, become a part of that which we take into our mouth, the recognized route of infection. The researches of Jordan, Russell and Zeit, in Chicago, in 1904, disclose the fact that Bacillus typhosus will live from three to five days in sewage, and only about one per cent. are remaining at the end of ten days in relatively pure water. Sedgwick and Winslow, in 1902, demonstrated that 99 per cent. of the organisms in ice will die within two weeks. In soil the evidence as to its life is not so definite. It, however, appears that there is an inverse relation between the amount of organic matter in the soil and the life of the organism, that is, if the soil is highly charged with nitrogenous matter, just as in sewage, the typhoid organism will die within a short time, but if the soil is somewhat sterile and the organism is allowed to dry, it seems that its life will extend over quite a period. There is, however, this matter to be kept in mind: that the ordinary passage of the typhoid organism from the soil would be through the medium of water washing the ground, at which time it becomes liable to the limitations as to its life in water. The most startling facts regarding the life of typhoid organism outside the human body are its life in milk. Contrary to the condition which obtains in water and ice, there is not a dying out of the organism when present in milk, but a very rapid multiplication. Experiments were conducted regarding this last year in Washington, during the study of the typhoid situation there. A sample of milk was inoculated with 78 typhoid bacteria per cubic centimeter, or one-half teaspoonful; within 24 hours there were 60,000 of the organisms present, and within 48 hours, 10,000,000 per c. c. When it is taken into account that within the 24 and 48-hour periods are the times at which milk is used for human consumption, and that it is taken, in the vast majority of cases, in the raw state, with no effort to destroy the bacterial life present, it is plainly evident that the milk that is infected with typhoid at its source will, by the time it reaches the ordinary city consumer, be an extremely dangerous article of human food.

Uncooked food may, by its previous contact with infected soil or water, be the abiding place of typhoid germs at the time of its consumption.

The fact that typhoid ordinarily is most prevalent during the late summer months has occasioned its study in reference to seasonal distribution. Sedgwick and Winslow, in 1902, after extensive researches, reached the following conclusion:

"The bacteriology and aetiology of typhoid fever both indicate that its causal agents cannot be abundant during the colder season of the year.

"The germs of the disease are carried over the winter in the bodies of a few patients, and perhaps in vaults or other deposits of organic matter, where they are protected from the severity of the season. The number of persons who receive infection from the discharge of these winter cases will depend upon the length of time for which the bacteria cast in these discharges remain alive and virulent. The length of time during which they will live depends largely upon the general temperature; as the season grows milder, more and more each crop of germs set loose in the outer world will survive long enough to gain entry to a human being and bear fruit. This process will be cumulative. Each case will cause more secondary cases, and each of the latter will have a still more extensive opportunity for widespread damage.

"The most reasonable explanation of the seasonal variations of typhoid fever is a direct effect of temperature upon the persistence in nature of germs which proceed from previous victims of the disease."

With these facts in mind regarding the life of the typhoid organism outside the body, it is worth while to consider a number of characteristic epidemics that have occurred with these things as agents of infection. Though the number of typhoid epidemics from water supply is constantly decreasing, and though there are doubtless far fewer water supplies in the country today than ten years ago, that can definitely be charged with being agents of typhoid propagation, there have been in the past, and may be in the future, a number of extremely severe and widespread epidemics from this cause. Cities such as Pittsburg and Philadelphia, before the construction of their filtration plants, were constantly subject to danger from a polluted water supply. An example of an epidemic from these sources is illustrated in the case of the Waterville epidemic of 1903. The towns of Waterville, Augusta and Richmond, Maine, all took their water supplies from the Messalonkee River. Waterville, the first town, or the town highest up the river, discharged its sewage into the river after taking its water supply from it; Augusta, a little farther down, took its water supply and discharged its sewage into the river, and the town of Richmond followed suit. In November, 1902, there was a case of typhoid fever at the County Poor House, above Waterville. The slops from the patient were thrown on the sloping bank of a small stream that emptied into the Messalonkee River about a mile below this place. In the middle of December there was a heavy rain and thaw, which washed the frozen slops from the bank into the water and carried them down into the river. Within two weeks there was a decided epidemic present in Waterville. About the middle of January, just the time it would take for the sewage from Waterville to travel to Augusta and the infection to develop in the bodies of the persons, the epidemic broke out in Augusta, and within a short time the same thing occurred in Richmond. During the months of January and February, in these three towns, there were 612 cases and 53 deaths, which were unquestionably due to the failure in the particular instance of the attendants at the Poor Farm properly to disinfect the slops of this one patient, and in general to the failure of those people responsible for the public supply at these towns properly to safeguard them against typhoid pollution, and the failure of the people themselves to recognize the certain danger to which they were subjecting themselves in using a water supply from such source.

An epidemic, which was caused by an ordinarily well protected water supply is shown in that of Butler, Pa., where in the fall of 1903, at the same time a reservoir above town which was used for the impounding of the unpurified water and the filtration plant, which was ordinarily used to purify the water, were both taken out of commission, and the water drawn from an old intake below some of the sewer openings of the town. Within ten days after this occurred there was a decided epidemic of typhoid in the town, and within six weeks 1,270 cases occurred, with 56 deaths. This is an instance where an ordinarily well protected water supply, through the failure of those connected with its operation, became highly polluted and a source of typhoid infection.

There is an Indiana town which has a very well constructed mechanical filtration plant, and a quarter of a mile above the intake of the filtration plant is the discharge of the sewers of the town. There is no question but that in this instance there is the same latent danger as there was at Butler, Pa.

I have not as yet made any mention of the agency of flies in the spread of typhoid. They are unquestionably the source of a great deal of the typhoid of the present day. The habits of the insect, its fondness for decaying or putrid material, its tendency to crawl about over food, and the fact that its body is a potential lodging place for myriads of germs, makes it a likely factor in conveying typhoid to individuals. One of the most striking instances of the agency of flies in the spread of typhoid fever occurred during the Spanish-American war, at Chickamauga Park. The method of sewage disposal at this place was simply the use of open pits and the sprinkling, at certain hours of the day, with lime. It was a noticeable fact that during the middle hours of the morning and afternoon these sewage pits were filled with flies, and at the meal times the food on the tables in the mess-tents was covered with flies that had white feet. There is not in recent history recorded so severe an epidemic of typhoid as occurred among the soldiers of the American army at this camp, and the report of the experts regarding this is to the effect that the water supply could not in any way be held responsible for the disease, but that the flies, acting as carrying agents from slops to food, were directly responsible for the greater majority of the typhoid cases.

An interesting fact from the same conditions is that at the Miami, Fla., camp, the First Division of the Seventh Corps, using flushing troughs and running their sewage away in a stream, had 172 cases of typhoid per regiment. The Third Division, using open pits on sandy soil, where there was large opportunity for drainage, had 186 cases per regiment, while the Second Division, using open tubs, and carrying them through the camp for final disposal, had 299 cases per regiment. Does this not instantly suggest flies as an agent?

Jackson, of New York, in 1906, demonstrated that the period of greatest prevalence of flies at the sewer outlets was also the period of the greatest prevalence in typhoid, and that typhoid in New York City is most prevalent in districts adjacent to sewer outlets. Quoting from his report:

''The time of appreciable prevalence of flies during 1907 was the three months beginning the first of July and ending the first of October. By far the greatest number occurred in the weeks ending July 27th and August 3d. The deaths from intestinal diseases rose above the normal at the same time at which the flies became prevalent; culminated at the same high point; and fell off with slight lag at the time of the gradual falling off of the prevalence of the insects. . . . .

''This chart for 1907 demonstrates the relationship between the activity of flies and the deaths from typhoid fever and other intestinal diseases. But in order that there should be no doubt left in the minds of those who may be skeptical on this point, a further demonstration of this matter was given in the form of a diagram extending over the five previous years and showing each year the almost precise correspondence between the temperature curve which indicates the activity of flies and the curves of the typhoid fever and other intestinal diseases. In each year it will be noted that the secondary rise appears at about September 20th in the deaths of intestinal diseases of adults and some five days earlier in children. This corresponds to the secondary rise in the prevalence of flies just as is shown in the diagram for 1907. . . . .

''Much to be feared is the common house fly. This so called harmless insect is one of the chief sources of infection, which in New York City causes annually about 650 deaths from typhoid fever and about 7,000 deaths yearly from other intestinal diseases. We are in the habit of considering the Fall rise in typhoid deaths as inevitable. The Fall rise, if set back two months from the report of deaths to the time of the contraction of the disease, will exactly correspond to the curve of prevalence of flies and to the curve of rise in deaths from intestinal diseases of both children and adults. It also corresponds to the temperature curve. We are therefore erroneously inclined to view the disease as due to hot weather. While climatic conditions, by reducing the vitality, favor the contraction of the disease, they are not the real cause of it. Temperature does not produce the specific germ which invariably accompanies the disease. The activity of the house fly is in proportion to the temperature; and the time at which it is most active and most numerous corresponds exactly with the time of the contraction of typhoid fever and other intestinal diseases.''

Regarding milk as an agent of typhoid, Busey and Kober traced 138 epidemics of typhoid to the milk supply. In 109 of these there was typhoid fever at the farm or dairy; in 54 instances where well water was used in washing cans, and in 13 of the places where it was used for diluting the milk, the water was polluted; in 6 instances the disease was traced to the fact that the cows waded in highly polluted sewage water and were not properly washed before milking, and in 21 cases the employes of the dairy, who milked their cows, were part of the time nursing typhoid patients, and in 6 further cases, persons who became ill with typhoid worked about the dairy until they were taken to their beds.

These are simply figures illustrative of the portion of typhoid epidemics that may occur through the agency of milk. The ways that typhoid may be transmitted to the milk are: from the hands of the milker, due to a failure to wash them properly; infection either from his own illness or from those persons whom he is attending; from the dust in the stables which may be impregnated with dry slops which have been improperly disinfected; from the milk-pail, which may have been handled by infected persons or washed in polluted water; the uncleanliness of the milk-cooler or cans at the distributing station in the city.

All the above causes are effective, and then further in the city, the improper care of the bottles that are used in distributing the milk. To my mind, one of the most dangerous sources of typhoid fever is the method, as practiced at the present time, of distributing milk in bottles. I do not intend to convey the idea that the sale of milk in bottles, theoretically, is not the proper thing, but the failure of the persons bottling the milk to sterilize them properly, or, in some cases, even to wash the bottles is a dangerous practice. It is a well-known fact that persons having a case of typhoid in the family will buy bottled milk and keep a certain bottle for the use of the patient alone, to be handled only by the nurse. The handling of this bottle with unwashed hands, or perhaps the handling by the patient himself, represents the possible source of carriage of the typhoid organism from the body of the ill person to the milk or bottle, and upon the return of this bottle to the distributing station it is refilled without proper sterilization. An epidemic at Montclair, N. J., was traced to this very fact. It may be an extreme opinion, but basing it on data regarding the milk supply of cities and upon examinations of the milk supply of Indianapolis at the present day, I am of the opinion that milk in an uncooked state is an unsafe article of human food. If it were possible for the many sources of milk supply to be investigated, it would be found that some of these factors above enumerated as sources of infection affected the milk supply of Indianapolis and many other cities, and that many cases of typhoid could be traced to them.

Modern thought on this subject opens two facts which are not so well understood. One is the contact method of infection or the passage with no, or a very brief, intervening medium from a sick to a well person. The handling of clothes from a sick room, nursing, or the contact with one of the above-mentioned bacillus carriers, who give off typhoid for years, is an element whose importance is being seen to be great. The failure to recognize this in the past has been due largely to the oft-quoted statement that typhoid is infectious but not contagious. That is not true. It is contagious—so much so that today, in Germany, it is quarantined as we do smallpox. The only reason that so many persons do not succumb to typhoid as do to diphtheria or smallpox is that the ability of the body to withstand and overcome typhoid infection is greater than it is in the other cases. It is a unique, but perfectly certain fact, that in those places where a severe epidemic of typhoid has occurred, and it has been traced to a certain source, only a small proportion of the people receiving the infection become ill. There seems to be the ability to receive the germs into the body, and yet, by virtue of proper conditions there, resist their multiplication and throw off the disease. It is with this in mind that the idea of vital resistance has reached a firm basis—that the final and important line of defense against typhoid fever is personal cleanliness, temperance in eating and in habits. The fact that typhoid is most prevalent during the late summer months, when the energy and vitality of the individual is weakened, lends emphasis to this idea. There is in this line the contribution of Major Roberts of the Indian Medical Service in a monograph on the Prevalence of Typhoid Fever in India, in which he demonstrates the fact that 62 per cent. of mortality from typhoid among the European troops occurs during the hot season, while only 37 per cent. of the mortality from this cause occurs among the Indian troops, and the remaining 63 per cent. occurs during the cooler season. This simply brings forth the idea that the morbidity from this source is dependent upon that seasonal condition to which the patent is least accustomed by heredity and past life—that is, in the case of the European soldiers, the hot season being devitalizing, renders them most susceptible to typhoid infection, while for the Indian soldiers, the cold season being that to which their mode of living is least suited, renders them most susceptible. It is notable, further, during the epidemics of typhoid in Washington, D. C., during 1906 and 1907, that the cases of typhoid fever did not develop gradually with the increased heat of the summer, but followed very closely periods of extreme heat. The fact that Europe has had so much lower rates from fever than many American cities having sanitary conditions equally as good, may be partly explained by the fact that the equable climate there does not overtax the people's vitality, while in America the conditions are such that we are subject to greater extremes from season to season.

These factors are responsible for the growing idea that typhoid fever is not alone a disease which depends upon outside factors for its spread, but largely upon the physical condition of the person infected—just in proportion to the general health-tone of the person, his method of living and the seasonal conditions being favorable or not, so varies his liability to develop typhoid after receiving the infection.

Weighing the various factors above outlined, and taking into account the influence of season and endurance of life of the organism outside the body, it appears, disregarding extreme epidemics which may be accounted for by the severe infection of one of the agents—water and food—that the normal, or, as some term it, "necessary" typhoid is *usually and permanently produced,* from season to season, through *infection by contact, this being favored by light, unrecognized cases,* and the *persistence of the organism* for a long time after illness, and its importance increased in proportion to the unhygienic modes of living.

Among articles of *food, milk* is the *most potent* agent of transmission, and the *water supply,* except in epidemic instances, is a factor of *secondary* importance.

And so we have the problem—typhoid—annually responsible for thousands of deaths, due to the entry into our body of the product of some other's disease. Against it the defense can not be made singly. No *individual,* no *community,* can stamp it out alone, but only by a co-operative effort in which the *whole state* and *nation* engages. The state and the municipality may form a line of defense in the protection of watersheds, prevention of stream pollution and filtrations of the water supply; they may through their Boards of Health so vigorously guard the milk and food supplies and their production, as to render them safe; they may by compelling the proper disposal of waste, exterminate the fly. The family may, on the smaller scale, protect their food and water, and, by proper screening, prevent fly contamination. But, last of all, must the individual so regulate his food and drink, his method of living, and maintain his general health tone as to render the attack of the germ harmless. And *first* and *last,* greatest and most necessary is the step of the typhoid patient and attendants—the destruction of the infection proceeding from his diseased condition. Upon this depends the whole matter, and with this properly done all the rest would be but a matter of form. And we can not ignore this problem.

"For we are not dealing here with questions of which the interest is abstract only—but with a matter which, take the world over, for every year that passes, is life or death to thousands of men.

"And let no one suppose that this is a matter in which he has no personal interest. This disease not seldom attacks the rich, though it thrives most among the poor. By reason of our common humanity we are all, whether rich or poor, more nearly related than we are apt to think. The members of the great human family are bound together by a thousand secret ties, of whose existence the world in general little dreams. And he that was never connected with his poorer neighbor by deeds of charity or love, may one day find, when it is too late, that he is connected to him by a common bond which may bring them both to a common grave."

DISCUSSION.

Severance Burrage: The fact that the life of the organism outside the body is short makes it possible to stop the disease. If people would realize this, we would very shortly stamp it out. We oftentimes look upon a sewage-laden pool and hear people say—a breeding place for typhoid germs. They don't multiply there; the germs are warring against the typhoid germs. They do not multiply; they die out as the stream flows along. I think Mr. Jordan perfectly correct in stating that the water supplies have too frequently been condemned as sources of typhoid infection. They may be the source of the first few cases, but flies or other distributing factors, are the cause of subsequent cases. I would also emphasize the freshness of the bowel discharge as important in producing the disease; the fresher the bowel discharge, the more severe the disease will be. I want to congratulate the audience on being able to hear such an interesting and concise paper on this subject.

Dabney H. Maury: I wish to bring to your attention a case which came to mind a few years ago, which seemed to me to disclose a new and unheard of source of typhoid infection. The chief engineer of our plant had a fine system which he built himself, and in which he had great confidence; he had recently cleaned it, when some few days after a man came around with a diaphragm system and asked to clean the system; he was told that the system had just been recently cleaned; yet he insisted. ''Let me put this pump down and see what I can get.'' So the man rather skeptically agreed. He ''diggled'' the pump, withdrew it and emptied out a good-sized cup of angle worms. The engineer told him that the worms were in the cup in the beginning; but he got a tomato can and tried again, and half filled the can with worms. The point is that especially in the dry season angle worms will go after water. They have a slimy sheath that would naturally cause them to adhere to anything in the medium through which they pass. They delve in the worst soils, and as the earth gets dry, they go down the slimy sides and get in. It seemed to me at that time that was a possible source of infection overlooked, especially so since a large number of cases had to be traced to cistern water; no city supply in the city.

Dr. J. N. Hurty: It may be interesting to gentlemen here to know one particular fact about what we call bacteria—the one-cell organisms; they are immortal; they do not die; they are killed by the millions; putrefaction is always attended by offensive odors which are very destructive to the germs, but the microbes proper are immortal. They do not die; they are killed by fire, by poison; our bodies are continually waging war against invading germs, and they are killed every day in the bodies. Dr. Roseneau's experiments, made by himself, show that the number of organisms is a very important matter in determining whether or not the individual is to have the disease. He made experiments upon guinea-pigs; found that one single organism of any kind (typhoid included) would not cause disease in even a weak pig, nor would two, three, four nor five; but he found that the average number necessary to inoculate with disease a healthy pig was 32. The number of organisms invading the body play an important part as to whether that body becomes diseased with them; bodies have the power to fight to a certain degree. In the Soldiers' Home there were three or four cases of clinical typhoid; such cases as doctors recognize by symptoms which characterize this disease. We went to investigate with all the apparatus to make examinations. They had an admirable water supply; the trouble was not in the water at all. We found after much study and investigation how it got into the institution.

A young son of the Commandant came back to the institution with the typhoid, and it began to spread after he had gone away to work. It was not passed by water; not transmitted by flies (we do not believe), but we do believe, from the thorough investigation, that it was passed on by contact—and finally every doctor in the institution came down with it. They simply got it on their hands from the individual—the nurses were dirty, and thus it passed from one to another until in all there were 68 cases. Mr. Jordan's remarks apply very well indeed. I know of a bakery where everything was clean, the water faultless, the baker woman typical in her cleanliness (being a German), yet her employes had typhoid. At last it was found that she was a typhoid carrier; examination of excretions showed she had been carrying the organisms for 27 years. Hardly a week passes but we have a letter telling about garbage and stagnant water, saying, "of course, typhoid generates there." It is not in garbage. One of the greatest dangers is raw vegetables, tomatoes, lettuce, etc. Everything should be cooked. Raw milk has killed more than all war and famines. Raw milk kills from 16,000 to 18,000 babies in Indiana every year. Mr. Jordan's is a paper of the very greatest value. I don't believe a medical man in the State of Indiana could have presented it in a more original and eloquent way. I congratulate you upon having heard the paper.

W. E. Taylor: At the water works with which I was once connected, on the hill about the plant were a few farm houses; two a quarter of a mile apart. The head of the family at farm No. 1 contracted typhoid in town. They received milk from No. 2, brought in cans; only a couple of weeks after delivering milk in this manner, children were taken down with severe cases of typhoid, undoubtedly due to infection of milk at the farm where typhoid existed.

Dow R. Gwinn: I want to express my appreciation to Mr. Jordan for his most excellent paper. I think it the best paper I have ever listened to or read on this subject. In ———, Iowa, 1904, there was a severe epidemic of typhoid—125 cases in all—cases in families using city and well water and also those drinking water from springs. Of course, the city water was charged up with the disease; the water works people were referred to as murderers, notwithstanding the water met the approval of the State Board of Health. The water was all filtered by a reasonably good mechanical filter plant with ordinary care. Question was where did it come from? Over half the cases were in families not using city water.

One man who delivered water from the spring some distance from the city took typhoid and died. Of course he was not using city water. Some time after the epidemic subsided it was learned that in a small creamery in that town, which was supplying butter to most of the inhabitants, the wife was taken sick with typhoid; the husband took care of her, made the butter and was selling it to the people. I think there is no question as to where that epidemic came from. Another case, in my own family, my boy, seven years old, took the fever. I asked the milk man if there was any one sick at his house, and he said, "Yes, my wife has been sick for six weeks with typhoid." There was where we got our case. The doctor said it was the only case where people had taken typhoid using city water exclusively.

WATER RATES AND RENTALS.

By Charles Carroll Brown, Consulting Engineer and Editor Municipal Engineering.

The current income of a water-works plant comes, or should come, from two principal sources: the users of water and fire protection. The revenues from water users may be for actual consumption, for domestic or manufacturing purposes, or from those who use water under pressure for power generation. Fire service may be supplied for general safety to the city or town or for private protection of factory, warehouse or other combustible property.

The division suggested in the subject of this paper applies the term water rates to the revenues received from users of water, and there is a more or less definite attempt to make the charge for such uses proportionate to the amount of water used. The term water rentals is intended to apply to the revenue received for fire protection. The value of this service bears no proportion to the amount of water used, and it is quite wrong to attempt to make the charge for this service depend in any way upon the amount of water used or supposed to be used for extinguishing fires.

The purity of the water supplies of this State is menaced in increasing degree each year, and the necessity of conserving it becomes greater by equal steps. This deterioration in public supplies must be stopped by reducing the amount of pollution reaching the water supplies, and the quality of many water supplies in the State must be improved by removing from the water before it is used the impurities which it now contains. This statement applies to many underground supplies as well as to practically all the surface water supplies which are not already filtered.

The smaller cities of the State, many of them, take their supplies from wells or galleries, and some of them are quite free from danger of pollution, but the limit of an underground supply is reached before the city reaches any great population, in economy if not in ability to supply the demand. It is unquestionably true that the supplies for the larger cities of the State must be taken from surface sources ultimately if they are not already so taken. The experience of Indianapolis in changing from wells to filters has been so satisfactory, both in quality of water and in quantity, and possibly in cost, that it is likely to serve as an example for other cities as they reach a size sufficient to give rise to troubles in keeping up the supply and to demands for water more satisfactory for commercial purposes than the ordinary deep well water of the State.

This straining after additional supplies to meet the increasing demands for water in some plants, and the purification of water which will be demanded in others will increase the cost of supplying water, and will result in a necessary increase in rates in cities where the rates have not been too high under the formerly existing conditions. Some discussion of the principles upon which water rates and rentals should be based is considered to be timely in the first conference which any large number of the water-works men of this State have attended, for a change of rates means a new contract with the city for a water company, and it means complaints from the rate-payers for a municipal plant, and there must be a safe basis of fact and well-developed theory in order to satisfy the other parties to the proposed new rate contract.

As to rates for water used. It is assumed that the books of the plant are so kept that the cost of supplying water can be ascertained, including all items of operation, maintenance, repair, renewal, interest, depreciation, sinking fund. There is much confusion in the meaning and application of these terms, but the limitations of this paper do not permit a discussion of this phase of the subject and the amount of revenue to be raised is therefore assumed to be known. The increase in cost of supplying water, due to the expense of the process of purification to be adopted, must be estimated unless the attempt has been made to operate without an increase in rates and the actual cost to run the purification plant has been ascertained.

The amount of revenue to be raised having been ascertained, the rates and rentals to be charged in order to raise it must be determined. There has been no very systematic study of the question of rates. The present schedules of flat rates are unscientific and often far from equitable. They differ in various cities for special reasons and it is practically impossible to make comparisons of rates. Every plant should keep its books in such form that the sources of all its revenues can readily be ascertained. This is so easily done that it is surprising water-works officials do not do it more frequently and then study carefully the effect upon income and upon customers of changes in the various rates. Then the superintendent should make meter readings of the customary use of water in various fixtures and he can make some reasonable estimate of the proportion of his total pumpage which each class of fixtures uses.

Theoretically the cost of supplying water, beyond a readily ascertained minimum covering all charges for ''readiness to serve,'' is proportional to the amount of water used. Practically, the water plant is disposed to encourage the installation of certain classes of fixtures and discourage the multiplication of others in the interest of the convenience of its customers on the one hand, and the conservation of its water supply on the other. Thus many plants make little or no extra charge for additional spring faucets in sinks or wash bowls in residences, convenience and not extra water being the reason for installing them, while they will make nearly or quite full charge for additional water closets, because of the greatly increased danger of waste with the addition of each closet. Such considerations as this can be taken care of in a well-designed system of flat rates. No difference can be made under a meter rate, which must apply the same rate to all water passing through the same meter, no matter what its use, unless by estimate on an agreed basis. The question of meters or flat rate services is an interesting one and belongs to this paper, but limitations of time prevent its consideration.

The water assessor and collector of St. Louis recently published a statement of the receipts of his department for six months, giving the details of receipts from various sources as shown in the following table, to which is added a column showing the percentage of the total which each item shows.

DOMESTIC USES.

Residences.	Number Using Water.	Rate Six Months.	Totals.	Per Cent. of Grand Total.	Partial Totals.	
1 to 3 rooms	16,860	$1 00	$16,860 00	1.79		
4 to 5 rooms	24,635	1 50	36,952 50	3.93		
6 rooms	10,141	2 00	20,282 00	2.15		
7 rooms	3,783	2 50	9,457 50	1.00		
8 rooms	3,679	3 00	11,037 00	1.17		
9 rooms	2,346	3 50	8,211 00	0.87		
10 rooms	1,172	4 00	4,688 00	0.50		
11 to 12 rooms	1,015	4 50	4,567 50	0.48		
13 to 14 rooms	313	5 00	1,565 00	0.17		
15 to 16 rooms	97	5 50	533 50	0.06		
17 to 18 rooms	25	6 00	150 00	0.02		
19 to 20 rooms	35	6 50	227 50	0.02		
					$114,531 50	12.16
Tenement rooms	217,195	50	$108,597 50	11.54		
Private baths	52,598	1 00	52,598 00	5.59		
Water closets	67,316	1 50	100,974 00	10.73		
Beds in lodging houses	2,392	25	598 00	0.06		
Sprinkling	......	.....	34,901 00	3.71		
					412,200 00	43.79

PUBLIC USES.

	Number Using Water.	Rate Six Months.	Totals.	Per Cent. of Grand Total.	Partial Totals.	
Public baths	172	$7 50	$1,290 00	0.14		
Public water closets	206	5 00	1,030 00	0.11		
Public urinal basins	709	10 00	7,090 00	0.75		
Churches	218	5 00	1,090 00	0.12		
Club rooms	62	10 00	620 00	0.07		
Schools (scholars)	14,728	02½	368 20	0.04		
Halls	193	2 50	482 50	0.05		
					11,970 70	1.28

ANIMALS.

	Number Using Water.	Rate Six Months.	Totals.	Per Cent. of Grand Total.	Partial Totals.	
Horses and mules	10,940	$1 50	$16,410 00	1.71		
Cows	3,923	0 50	1,961 50	0.21		
Vehicles	5,919	1 00	5,919 00	0.63		
Stable hose	672	2 50	1,680 00	0.18		
Livery hose	23	25 00	575 00	0.06		
Dairy hose	122	10 00	1,220 00	0.13		
Stalls in stables	955	1 00	955 00	0.10		
					$28,720 50	3.02

BUSINESS HOUSES.

(Shops, Stores and Offices.)

	Number Using Water.	Rate Six Months.	Totals.	Per Cent. of Grand Total.
Stores	3,084	$5 00	$15,420 00	1.64
Shops	6,943	2 50	17,357 50	10.84
Offices	2,130	2 50	5,325 00	0.57
Barber shops, 1 chair	14	2 50	35 00	.....
" 2 chair	270	3 50	945 00	.....
" 3 chair	204	4 50	918 00	.....
" 4 chair	42	5 50	231 00	.....
" 5 chair	12	6 50	78 00	.....
" 6 chair	9	7 50	67 50	.....
" 7 chair	1	8 50	8 50	.....
			$2,283 00	0.22
Beer pumps	308	$10 00	$3,080 00	0.33
Billiard tables	453	1 50	679 50	0.07
Candy and ice cream saloons	57	7 50	427 50	0.05
Restaurants	268	10 00	2,680 00	0.28

	Number Using Water.	Rate Six Months.	Totals.	Per Cent. of Grand Total.	Partial Totals.	
Saloons	1,578	$10 00	$15,780 00	1.68		
Lunch rooms	212	7 50	1,590 00	0.17		
Photo galleries	11	10 00	110 00	0.01		
Ten pin alleys	136	1 50	204 00	0.02		
Warehouses	398	2 50	995 00	0.11		
Washing bottles	73	12 50	925 00	0.10		
Buildings	......	.....	22,197 50	2.36		
					89,054 00	9.45

MANUFACTURING PURPOSES. SMALL SHOPS.

	Number Using Water.	Rate Six Months.	Totals.	Per Cent. of Grand Total.	Partial Totals.	
Tobacco and cigar factories	79	$5 00	$395 00	0.04		
Bakeries	261	5 00	1,305 00	0.14		
Ovens	368	5 00	1,840 00	0.19		
Foundries and forges	302	1 50	453 00	0.05		
Dyeing and cleaning shops	17	12 50	212 50	0.02		
Laboratories	33	12 50	412 50	0.04		
Laundries	153	10 00	1,530 00	0.16		
Hot houses	149	2 50	372 50	0.04		
Soda water factories	24	25 00	600 00	0.06		
Minnow tanks	9	7 50	67 50	0.01		
Boilers	434	.....	5,771 50	0.61		
Hands employed in shops	9,572	1 00	9,572 00	1.02		
Gas-engines, 285 h. p.	......	1 50	427 50	0.04		
					$22,959 00	2.42
Meters	......	.....	$367,823 80	39.08	....	39.08
Permits and taps	......	.....	7,963 95	0.85	....	0.85
Miscellaneous	......	.....	673 95	0.07	....	0.07
						99.98

Even with such a guide as this there will be much difference of opinion regarding the propriety and the proportion of the various rates. This difference of opinion will be less among the officers of an individual plant, who have a similar statement of the returns from their own schedule of rates before them, than it would be in a body like this which is discussing the general features of the problem.

Whatever the schedule of rates may be, unless it has been really higher than it should be, it must be increased when the expense of water purification is added. This expense is a burden put on every gallon of water, and it should be added to every gallon of water delivered. With the flat system of rates this can scarcely be done unless the measurements of the use of water by various fixtures have been made, so that the superintendent has some knowledge upon which to base an estimate of the relative increases that should be made in the rates in order to bring the additional revenues required. The simplest method of making the addition is by increasing the income from each rate as shown by such a table as that of St. Louis, by its percentage of the whole and then increasing the rate itself the amount necessary to produce this increased amount.

This required increase in income makes it possible, however, to readjust the existing rates so that they shall be more nearly in accord with a well-considered system, by placing the increase on the rates which are proportionately too low. This method of increasing the rates should bring less complaint from customers, as well as supplying valid arguments to meet such complaints as may be made.

For the water supplied by meters the problem of proportionate increase in rates is simpler. Some may say at first glance that it amounts simply to the addition of a percentage to the existing rates, and this is true if there is but little variation in the sliding scale. But, as already stated, the cost of purification is a burden on every gallon of water and it would seem to be most equitable to make the increase by the direct addition to all of a rate per gallon, based on the total increase in cost and the total amount of purified water delivered.

The water used in putting out fires is not materially improved for that purpose by the process of purification and it would seem proper, if the payment for that service is already on a proper basis, that its price should not be increased. However, so far as the public fire protection service is concerned, the city at large is vitally interested in the supply of pure water and should be willing, through its general fund, to pay a material proportion of the cost of purification. Indeed, in some cases, particularly in municipal plants, the city at large should pay the whole cost of purification and even then would not be paying its fair share of the support of the water plant. Some discussion of this subject is necessary because very few cities pay the correct amount for their fire protection and public uses, and the required increase in rates will give an opportunity to make the correction.

Supply of water to actual users of water requires comparatively small pipes, only sufficient to carry the maximum draft at any time of the day, week and year, which is probably less than three times the rate of flow for the average consumption. Supply of water for fire protection requires pipes large enough to make it possible to deliver a large amount of water in a very short time to a restricted district. Except for this short time, which may recur at very infrequent intervals, in any one locality, the large size of pipes is of little practical benefit to the system.

An application of the theory that the hydrant rental for fire protection should pay the charges due to this increase in size of pipes and in capacity of pumps and of water supply was made a few years ago by D. H. Sawyer in a paper, an abstract of which was published in MUNICIPAL ENGINEERING, Vol. XXIV, p. 182, and discussed editorially on page 189. He took four towns and cities ranging in population from 1,000 to 35,000, but otherwise under similar conditions, and designed plants for domestic service only and for combined domestic and fire service (with no cost of water purification). He assessed the annual charges necessary to take care of the difference in cost upon the hydrants, and found the rates per hydrant to range from $46.49 to $58.86; averaging $51.12 per hydrant per year. This average happens to agree quite closely with $47.88, the average in 32 cities of the middle West of 500 to 105,000 population, and $49.43, the average of 544 cities in the whole United States. In the first group of cities the range is between $33 and $80 and in the larger group it is between $5 and $160, so that while the averages are quite near the theoretical rentals, according to Mr. Sawyer, individual cities vary widely from it.

In his presidential address before the American Water-Works Association in 1907, published in MUNICIPAL ENGINEERING, Vol. XXXIII, p. 167, Mr. D. H. Maury discusses this same question, and he states that an average of available estimates by eminent authorities shows that the average annual cost of furnishing fire protection is about 50 per cent. of the interest and other fixed charges due to the cost of construction of the works, plus about 20 per cent. of the annual operating expense. Mr. Sawyer's cases do not vary greatly from this estimate. The individual city or town should make these computations for its own particular case and should base not only its public hydrant rental charge upon them, but also its charges for such private services as automatic sprinklers, private hydrants, standpipes, etc. If the city has been paying less than the amount thus computed, enough of the added cost of purification should be put on the city fire protection charge to bring it up to its proper basis. If the city has been paying more, then the greater part of the charge should be put upon private rates. This should be done whether the plant is under private or municipal ownership.

City payments are sometimes disguised so that the actual amount paid by the city must be carefully investigated. In some cities under municipal ownership there is no charge for hydrant rental, but interest charges, repayment of bonds, appropriations to meet deficiencies, etc., may equal or even exceed a proper hydrant rental. This is bad bookkeeping and should be corrected. A long paper could be written on this subject, which is closely connected with the subject of this paper, but cannot be considered here.

DISCUSSION.

Frank C. Jordan: I have given some attention to this matter, have visited a number of plants over the country and found that sometimes the published rate in the rate book can hardly be construed as the actual rate. I called on our State Statistician and listened to her in regard to getting correct data. I have been much impressed with this fact, that anybody who goes into this question should be careful to consider existing conditions at various times. It is unfair to say Terre Haute should compare with Detroit (the latter having the Detroit River with all the water needed); or that Richmond should compare with Chicago, or that the Indianapolis rates should be no higher than those in Cleveland, because the conditions are different. A few weeks ago I came across this proposition: the Council said that the rates in a certain town should be no higher than those in St. Louis. I stayed some time in St. Louis and found a remarkable condition of affairs there, $19,000,000 as an investment of the city; people invested a little over $11,000,000. The city comptroller told me that if reasonable interest were paid on the money invested the rates in St. Louis would be a little over double. Yet this Council said that rates should be no higher than schedule rates in St. Louis, and was not willing to take into consideration the $11,000,000 of the people in the plant. We have received information on this point from practically every city in the United States, and one of the most interesting ones was from St. Paul. I questioned how a town could get along with such a rate. This information that the property owner who has a main in front of his house has an investment of about $40; the man across the street, $40, makes $80 for every 40 feet of pipe. As you may know, St. Paul has a large per cent of small pipe; with $2 for every foot of pipe laid, they can afford to sell water a little cheaper than the average plant. Another question is hydrant data. Again the same question of condition comes up. Terre Haute or Richmond, where they furnish fire pressure, should receive a higher rate than Detroit, Cleveland or Chicago, where they not only supply water at the hydrant, but are compelled to pay for fire engine operation, and at every fire operate those engines. At Indianapolis, engines are operated at 2 per cent of the fires. A man here from Chicago asked how many engines we have; he was told, and he asked, "How does a man get along with that many?" He was informed that the engines were operated at only 2 per cent of the fires. He said he didn't see how that could be possible. He then told figures as to what it was costing Chicago today to maintain fire engines. In Louisville, after the recent change in management, much to the people's surprise the first thing done was to make a rearrangement of the rates, for they said it was impossible for any plant to operate under the rates paid by the people in Louisville. I want to emphasize again that in gathering data, on whatever committee that devolves, great care should be taken to give a town credit for the conditions existing there, and simply make that town compare with one of like conditions. I would like Mrs. Moore, State Statistician, to tell you something of the trouble experienced in gathering statistics.

Mrs. Moore: Our department has been very much hampered by not having a sufficient amount of information to cover all reports. We try to secure information from all city and town clerks—try to secure figures of electric light and water-works plants. Different things must be taken into account and the figures are very hard to obtain, and we cannot in any way make a report that is very satisfactory. However, the report this year will be more efficient than any previous year, and we hope it will be of some use to all of you.

D. H. Maury: In connection with the difficulties met by Mrs. Moore and Mr. Jordan in acquiring accurate statistics, I should like to cite some I met with in my investigation when looking up matter for the National Civic Federation. Reference first is made to Chicago; it was published broadcast that the revenues from the Chicago plant were $4,000,000; that their expenditures were $2,000,000, bonded indebtedness practically nil. Taking Chicago as an example, I find out that, first, a very large part of the plant was built by assessment; second, that, as has been brought out by Mr. Jordan, it has an unusually large appropriation for fire protection—something like $4,000,000 per annum; maximum pressure will not exceed 30 pounds, close to one station 40 pounds, and large areas with 10 pounds, necessitating complete steamer equipments all the time. Also, I found that consumers, due to lack of confidence, paid nearly $700,000 per annum for drinking water, simply for such waters as are commonly known as ''table'' waters. The health board reported that water was bad 17 per cent of the time, although this fact simply that it was not up to the standard did not necessarily mean that the water was bad or caused disease when reported bad. I don't know where I have seen a more misleading impression than from reading the Chicago reports as to profits, when, really considered, there is a very heavy loss. Another municipal plant, admirably managed, which I have had the pleasure of examining, is Cleveland. While a great deal of comment on the way in which statistics were set forth to meet the public eye was very misleading, statements affecting matters of Cleveland water-works were so made that one would get a very mistaken idea of the true conditions. It is needless to say, on the other hand, I found the same endeavor in the private plants to put the best foot forward as in city plants, but as they did not publish any annual reports, I did not have the opportunity to criticise to the same extent.

E. H. Loomis: I am much interested in this subject; next to the question of health comes that of rates. Mr. Powers, Chief Statistician of U. S., since the session of the Water-Works Association, has spent a great deal of effort on this proposition, and made out a form for annual reports. I happen to have with me the outline which he prepared; were it not for the fact of its length, I should be very glad to have it read to this association, but it is a document of some 50 pages of closely type-written matter, and of course it is too long to take up. This proposition is in charge of Mr. Gwinn, on behalf of the American Water-Works Association, and I believe it would be a desirable thing to have Mr. Gwinn take up this question with our State Statistician, with the idea of giving him some suggestions on the question of obtaining such statistics as would be desirable. We know the ways in which they are obtained; one city will want to compare with others and simply send out letters, get rates and compare them, when, as a matter of fact, there is no basis of comparison of the different conditions as spoken of so many times. One other thought is the question of franchise, which should always be considered in making up questions of what rates should be; if I am operating a plant under 25-year franchise, and at the end of that time the plant is to be confiscated, I must have enough revenue in a sinking fund which I will get in that 25 years to let me out of the plant; in other words, I should have a fair return on the investment all the time, not simply the bonded debt or outstanding debt of the plant, but the whole investment all the time, but the sinking fund is enough to cover this investment at the end of the contract period. The Sioux Falls case, I believe, had as a part of the contract, that at the end of the contract period they should remove their plant. So far as I am personally concerned, I am not alarmed at the court decision in that case. I don't believe it means that when a contract expires the water-works shall be obliged to take up its mains.

F. A. W. Davis: Mr. Brown's paper is a valuable publication. Will it be published in Municipal Engineering?

C. C. Brown: It will.

L. C. Boyd: I agree with you that the papers are interesting and valuable.

G. A. Fletcher: Private companies are managed for finance; municipal companies are managed by the best "ward" heelers; the public using water from municipal plants are entitled to as good service as those organized for finance. I agree with your Mayor that water-works should be maintained by the municipalities. I also agree with Mr. Kennedy that the state should have a board for the regulation and management of public utilities. If the state had that, companies would not have the trouble they do in a great many cases with councilmen, whom some one referred to as "hack drivers," "merchants," etc., who know nothing about the management of public utilities. Mr. Brown's paper is a very good one.

H. McK. Landon: I think that every privately owned company would be glad to have just such a commission as the gentleman from Brazil wants in this State. The thing we are anxious about is that it shall have the powers needed by a commission of that sort, not only to regulate rates, but to regulate the municipal companies and provide for improvements when they are needed. This comes to my mind largely as result of Mr. Brown's paper and the discussion. Detroit, as you all know, has been a "thorn in the side" of every privately owned company for a number of years because their rates are so low. What are the conditions at Detroit as revealed in the last few months to the public, and known to every private water-works for a great many years. The National Civic Federation found in Detroit that 75 per cent of the pipe in that system was either four inch or six inch, and condemned the system as utterly inadequate for fire protection, and made a report that a great many miles should be reconstructed with new mains. I noted recently in the paper that over ten millions would be required to put the plant in shape to meet the requirements. When it was necessary to lay pipe in Detroit, they laid the smallest size that would answer, and have so added until they have 75 per cent of six inch or smaller. That ten millions will come out of the taxpayers. If every plant which is publicly owned were controlled by a commission (with the expert advice needed to guide them) and compelled to design the system as it should be, and to change rates accordingly, no privately owned company would have any trouble at all in regard to rates. So I say we are in favor of the commission provided it have these powers. Nothing can be more misleading, gentlemen, than any uniform system of accounting, such as the Chief of the Bureau at Washington is working out, unless that system of accounting also takes in account the character of the system—whether it is adequate for the purpose it is designed to serve. In the case of Detroit, their accounts are well kept; their reports are among the best which come to our desk, but the condition has been covered up, and no system of accounting would show that condition. What we need is more than the receipts and expenditures—we need the character of construction designed, with future growth of the property, and the demands which it will have to serve.

G. A. Fletcher:. Don't understand that in my remarks I had reference to the superintendents of municipally owned plants. Some of them have been the nicest men I know. It is nearly always the case that they have their hands tied by the chairman of the water-works. There is where we are tied.

Howard A. Dill: If I understood Mr. Kennedy right, a few minutes ago, he would arrange schedule of rates of companies in this State by getting all the rates and taking the average. I must take exception to him in that method. I think every plant ought to stand on its own merit. You have mentioned the Wisconsin law; their plan is for Public Utilities Commission experts to go over every individual plant, then they allow for depreciation, interest charges, and so on, allow reasonably liberal return; and say to that city "you can divide your revenue (either municipal or private) in whatever way you please between private consumers and hydrant rentals, but this company is entitled to certain revenue." In that way every company is individual from the other. You can't compare accurately one city's rates with another.

E. H. Loomis: That is just the point that the Chief Statistician of the U. S. is trying to get at—a comparable basis. I believe this proposition of sufficient importance, if we had the time, to go into more at length just as this time, as the question of rates is constantly up. If we could get this information on a comparable basis (which I think is possible), it would serve an excellent purpose; so, if in order, I would like to move, Mr. Chairman, that a committee be appointed to take up the question with the State Statistician, with a view of having a report before adjournment.

F. C. Jordan: I think it well for a committee to be appointed, but suggest that the report be filed at a later meeting.

Motion seconded.

E. H. Loomis: I accept the suggestion of Mr. Jordan to defer the report until later—at some other meeting.

The motion was put before the convention and passed.

The report of the Committee on Resolutions was then read, as follows:

Whereas, Owing to the increasing and congesting population, inhabiting the natural water courses and water sheds of the State of Indiana and the utilization of such streams for water supply being necessary for the very existence of the towns located thereon, and,

Whereas, The use of streams as a common carrier for sewage, manufacturing and industrial waste, abattoir rejection, etc., is a grave menace to the public health and life of a community, and,

Whereas, We strongly believe that the time is at hand when our citizens should receive such protection from pollution of surface water supplies on which they are becoming more dependent each year, owing to the receding and diminution of ground water; therefore be it

Resolved, That measures be inaugurated towards establishing sanitary districts on the various grossly polluted streams and surface waters of the State, whereby such waters utilized for domestic purposes can be safely used without danger of pestilence and death;

Resolved, That we advocate the passage of laws relating to the pollution of water sheds and streams by municipal and industrial waste, and that we petition the General Assembly to pass such necessary laws governing stream pollution, and especially prohibiting the use of streams as carriers of sewage from any towns or cities, without being first suitably purified in accordance with standards adopted by the State Board of Health.

Respectfully submitted,
Dr. J. N. Hurty,
Chas. Brossmann,
Howard A. Dill,
Committee on Resolutions.

Dow R. Gwinn moved the acceptance of the report.

Seconded by L. C. Boyd.

The report was unanimously adopted.

PRIVATE WELLS AND THE PUBLIC WATER SUPPLY OF INDIANAPOLIS.

Eugene Buehler, M. D., Secretary Indianapolis Board of Health.

I regret exceedingly that it is possible to say anything about the wells of Indianapolis, for had we our way there would be no wells instead of, as now, between 18,000 and 20,000 wells in daily use. The majority of these are driven in drift, the average maximum depth being forty feet. There are about forty deep rock wells other than those of the water company, located in office buildings and in factories, varying in depth from 300 to 1,000 feet. Of these latter nothing need be said, for, excepting its hardness, and the excessive iron content the potability of the water is unquestioned.

Of the other class I need only say this: that in addition to having a driven well on the premises, there is also a privy vault, usually within twenty-five feet, and so constructed that it permits the fluid contents to filter into the ground, making frequent cleaning of the vault unnecessary. And when I add to this that the city of Indianapolis has no ordinance compelling sewer connections, nothing further need be said of the possibilities of such a water supply.

The question might be asked, why not pass an ordinance prohibiting the use of wells within the city limits? There are reasons why such a law would not be practicable at this time. First, because of the rapid growth of the city. More than nine square miles have been annexed in the past five years, and as there are no water mains in the new territory wells are a necessity. Secondly, there seems to be a deep-rooted belief on the part of many people that well water is much to be preferred to filtered river water. Whether it has its foundation in the fact that in the summer months the well water is cooler, requiring no icing, or whether there is a real prejudice against the corporation supplying the water, I am unable to say. The fact remains, however, that no amount of persuasion on the part of the department of health that the public supply is above suspicion seems to avail with this class. If the public supply were under municipal control and not owned by a private corporation, there would be a possibility of having a law passed to close the wells, but as it now stands, whenever a well is condemned, some of the owners at least, believe that it is done in order to give the company another contract.

Last year 922 wells were examined and 428 were condemned.

We examine only such wells as are reported to us for examination or from premises which have been reported for typhoid fever or other sickness. There can be no doubt that many of the wells now in use are polluted and should be closed. However, since no systematic effort is being made to close wells and as every year new wells are sunk, a prominent well driver estimating the number between 900 and 1,000, it will be seen that, at the present rate and method of condemnation, we will have wells here for the next hundred years.

Now as to the methods employed in the examination of well water. It is the practice at present, and has been in the past, to classify the wells as follows:

Class 1. Water strictly potable, containing three parts of chlorine or less per 100,000 and no nitrites.

Class 2. Water considered as potable either because it is rain water or from a sparsely or recently settled district, or a deep well, or because it is beyond the reach of pollution from its location, such water containing less than five parts of chlorine and with not more than a faint trace of nitrites.

Class 3. Water on which judgment is suspended because the pollution is suspected to be due to temporary causes or to causes other than pollution of the veins of water. Chlorine may be present in excess but no nitrites, or conversely, nitrites may be present but no excess of chlorine.

Class 4. Water polluted somewhat, but not extremely bad. Chlorine seven parts or less and not more than traces of nitrites.

Class 5. Hopelessly polluted water from shallow or dug wells. Chlorine over seven parts and excess of nitrites or chlorine over eleven parts whether nitrites are present or not or even great excess of nitrites in the absence of excess of chlorine.

The actions depending on the above water classifications are as follows:

Class 1 and 2 are not sealed. Class 3 is not sealed after first examination but is re-examined in two weeks after the first sample is taken and then judgment exercised accordingly. Class 4 is sealed at once and a second sample taken in thirty days. The verdict of the second analysis determines whether or not the well is to remain sealed. Class 5 shall be sealed at once. This action is to be final and no re-examination is authorized.

The board's normal standard of purity is not over three parts chlorine per 100,000 and not more than a faint trace of nitrites. Any evidence of dangerous proximity of vault, cesspool or other source of danger to be considered before condemning the water supply. We realize that this is an arbitrary classification and not a scientific procedure and is successful only because it has not been seriously questioned. It seems to me there should be some uniform method of well water analysis and a fixed standard of purity established if that be possible, for, leaving out city wells entirely, we are often called upon to determine the purity of wells on dairy farms, which are important factors in the production of a pure milk supply.

Of the public supply, there are those present who are better able to speak than I. I will say, however, that we are making daily bacteriological and chemical analyses. The water is taken from public fountains located in seven different parts of the city and it has been found uniformly good, the filter efficiency being not less than 96 per cent.

In addition to examining the public and well water supply, we have been making daily bacterial examinations of the principal bottled waters sold in the city and in this connection an interesting condition was found. A comparison of the bottled and city water shows that the bacterial count of the city water has been uniformly lower, and that in one particular brand of bottled water the count has reached as high as 4,000 colonies per 1cc.

In closing I would like to add that I hope from this meeting some definite steps will be taken to establish uniform methods of procedure and to determine, if possible, the limits of safety in municipal water supplies. In other words, what the health officers require is some definite standard upon which to base a correct opinion as to the potability, not only of the well water, but also of the municipal water supplies.

POLLUTION OF STREAMS.

By F. A. W. Davis, President Indianapolis Water Company.

It will be seen from the following item that in 1896 the British Parliament had the subject of stream pollution under consideration.

"Lord Norton asked the Government to undertake to legislate on this subject (The Pollution of Rivers) in the direction desired by the County Councils Association. Such legislation had been undertaken by private members, but hitherto it had failed. Such legislation, indeed, must of necessity be in the hands of the Government. The legislation need not be difficult, since all that was needed was to make general the powers of procedure already successfully given in some local acts. The pollution of rivers was becoming a serious question to the health of the community, and the local authorities ought to have full power to deal with it. He could hardly hope that the Government could promise to legislate this year, but he hoped they would promise a bill early next session. There would be little opposition to it, and even if there was, opposition ought not to be allowed to stand in the way of a matter of such national concern."

In 1893 the United States Court for this district held that strawboard waste running from the works into the streams did pollute and injure the water of the streams, and granted a perpetual injunction.

Section 46 of the Constitution of Indiana says that all power is inherent in the people, and that all free governments are, and of right ought to be, founded on their authority and instituted for their peace, safety and well-being. Certainly in polluting streams the safety and well-being of the people are injuriously affected.

"Gould on Waters" says:

"Riparian owners have, also, a natural right to have natural streams flow unimpaired in quality as well as quantity; and any use of the stream by one proprietor, which defiles or corrupts it to such a degree as essentially to impair its purity and usefulness for any of the purposes to which running water is usually applied, is an invasion of private right, for which those injured thereby are entitled to a remedy."

The sewage from cities flowing into streams is pollution, and is of the most dangerous and serious kind. If a person should pour the contents of the night vessel into his neighbor's yard, trouble would be started at once. This is nothing more than what cities are doing to each other; the one at the head of the stream pollutes it, and the city below uses the water for its public water supply, and it, in turn, pollutes the water to a greater degree for the city below, and so on.

The law plainly says that every riparian owner is entitled to have the streams flow unimpaired in quality as well as quantity. If this be the case, what right has a city to discharge its sewage into the river? It may be claimed that the public interests are paramount to individual interest. It is certainly answer enough to say that the city lower down is the public as well as the city higher up the stream. Thus we have one city interfering with the rights of its neighbor below. Pollution of the streams by towns and cities is a great wrong, not only to the cities, but to the riparian owner of lands along and near streams, who is dependent upon the water in the river for his stock. The man who gets his livelihood by following the vocation of a fisherman, is deprived of his means to earn a living. The protection of the individual is protection for the whole. The water is rendered unfit for the fishes, the water fowls and the birds which are so useful and so necessary.

The town or city that gets water from wells should not be disappointed if the water recedes beyond the suction lift. Already many towns are resorting to air lift systems and various kinds of deep well pumps to augment their supply, and on going deeper for water, it is found to contain iron in an increased quantity; a little deeper, water is obtained containing sulphur, and a little farther down a water containing salt is obtained. So there is a limit to the underground water available for general purposes. In many cities well water is being contaminated by improperly filled joints of the sewer pipe and cesspools. Geological reports of the Government show, almost without exception, that the water, in wells that flowed with great volume and a good head, has gone down out of reach of the suction lift. In the city of Indianapolis, wells that flowed with an 8-foot head over low water in the river, are now 30 feet below the original head. This constant diminishing supply must be replenished by using surface waters, which should be protected from pollution.

The Barrett law, authorizing cities to improve streets and construct sewers—making the cost of the same a lien upon the property benefited, and payable in ten annual installments with interest—has been sustained by the Supreme Court of the state. If it is lawful to construct sewers for the benefit of the people, why can it not be made lawful to construct sewage purification works for the benefit of the people, and levy the costs in the same manner as for streets and sewers upon those using the sewers? If a city has a sewer system of 200 miles, and the purification works cost a million dollars, that is only about one dollar per foot, so that a man having a 50-foot lot would be assessed fifty dollars, payable in ten equal annual installments, with interest, if he did not wish to pay the cash.

Some of the issues bound up in stream purification are the beauty of the stream, recreation, happiness, food supply, and, far more important than any of these is the question of life and death. If we ignore them, are we dutiful citizens? A manufacturer will say that to purify his waste will increase the cost of production and lessen his profit. Is it equitable and just that any one concern or more, for its individual profit, should pollute streams wherein many are vitally interested? Is it not better to increase the cost to the consumer and do no wrong? A wrong done can never make a right.

The purification of streams is a duty devolving upon the United States Government as well as upon the individual states. The State of Indiana should see that the streams within its borders are not polluted. The United States must see that boundary streams are not polluted. The State of Ohio may compel streams within its borders to be freed from pollution, but unless the State of Kentucky and other states do the same, the efforts of Ohio, as far as the Ohio River is concerned, will be futile. The pollution of water is growing daily more serious. Cities bordering on lakes are menaced by the filth that they daily discharge into the lake. Michigan City and other lake cities are suffering from water pollution. The Chicago Drainage Canal is filling up. It is supposed that the solid matter of the sewage is doing the filling for the reason that the current is too sluggish to carry it away.

The decrease in the supply of subterranean water and the water of the streams—except at flood time—the constantly increasing population, and the increase in sewage discharge into the streams, make it necessary that the state laws be amended and that the State Board of Health be authorized to prevent stream pollution.

You, who are identified with supplying cities and towns with water, and you, who are guardians of the health and well-being of the people, will have failed in doing your duty if you do not put forth every effort to have laws enacted prohibiting stream pollution, with sufficient appropriations to enforce them for the peace, safety and well-being of the people. You undoubtedly will be called cranks—will be told that water flowing in streams purifies itself in twenty miles. Do not be turned aside by such ridicule and such statements, but, like an arrow, go directly into the work. Some of the grandest results for the welfare and advancement of the people have been accomplished by men termed ''cranks''; without a crank the engine is of little value.

It is actually wicked for cities to spend the money of the people, burdened with taxes, and pour sewage into lakes and streams that are exceedingly beautiful bodies of water, and then pump the polluted water into the city for the people to drink. Think of the little children being sickened daily by this polluted water! To obviate this condition they extend a crib, at a great expense, into the lake, and through this crib and its connection, the water is supplied to the city, but this supply does not remain uncontaminated because of the increased sewage, and another expensive crib and connection is built further out, and still at times the water is polluted from the sewage put into the lakes by the cities. The cities on the ocean pour sewage into it in such quantities that the oysters—one of the most delicious foods—are polluted and unfit for use.

Polluting a water supply and then attempting to purify afterwards, is a wrong proposition. It is far better and less risk to purify the sewage before it is placed in the water supply.

In the discussion in Parliament, above referred to, Lord Harris says it might be taken that the Act of 1876 was not so successful as might be wished, but the present law gave to the local government considerable powers.

In 1876 this country was covered with forests, streams—bright and sparkling, and not polluted—iron and coal mines undiscovered. From 1876 to 1908, a period of 32 years, we have devastated the forests, wasted the iron and coal, and polluted the streams to such an extent that the thoughtful are greatly concerned for the future welfare of the nation. It is certainly within bounds to say that at the end of the next period of 32 years, unless laws prohibiting the pollution of waters, restraining the waste of coal and iron, and requiring the replanting of trees, are made and enforced, this land will be without forests, mines exhausted, and the streams a reeking mass of filth and nastiness and a stench in the nostrils of the people.

The next address was given by George W. Fuller, Water-Works and Sewage Engineer, New York City.

Mr. Fuller used no notes and we regret we have been unable to obtain a copy of his address for publication. In introducing his subject he spoke as follows:

I am very glad indeed to be with you today at your first conference of this new association. I believe that these meetings of water-works people and health board officials will bring about much good. It should be of decided benefit not only to municipal and private companies, but as well to the private consumer. I have been affiliated with water-work business for 20 years, as an official of the State Board of Health and as an expert representative of water companies, and I have also had meetings with committees of indignant citizens. I realize that during the past 16 years there has been a marked advance in carrying out improvements and I believe from my observations that a good many cities have been aided in securing proper water supplies. It is the meetings such as this of officials with the state authorities that bring about more rapid progress in the future. These meetings should do a great deal towards bringing together the state authorities and the water-works people, and overcome what I may call a lack of belief and faith in the board by the water companies. I believe that there is only one thing to do in connection with water-works business, and that is to give a thoroughly reliable supply, to furnish a water clean and pure and to charge rates which will make it possible to do this at all times. I believe that plan should be the keynote of the water companies in this country. The matter of impure water comes closely into the family of everyone, perhaps bringing sickness and death, and then the questions which of course will naturally follow. The cost of the water supply must be adjusted to allow an improvement of those conditions and so fixed that there will be a good return to the private investor. I believe that this association is capable of doing much good and in bringing about laws which will be helpful. Those laws should be very carefully framed if they are to secure the backing of the state authorities. It is almost without question the only way of doing any good at present and probably for some time to come. If you make a bad start it usually means delay, and to advise the legislators as to safe conservative lines which they can best follow is a duty which I believe our association should look squarely in the face.

DISCUSSION.

E. L. Loomis: I certainly want to express my appreciation for the most excellent address which we have just heard. I was especially impressed with what Mr. Fuller had to say with regard to the work of the State Board of Health, and the willingness with which the water-works people should co-operate with them in this work, and I think we should look to them for this co-operation. In my city we have just got through with an experience with the State Board of Health. We have been constructing a filter plant at Valparaiso, and when the plans were prepared of course we brought them to Indianapolis and submitted them to Dr. J. N. Hurty. He O. K'd them and then the work was commenced. Dr. Hurty looked in once or twice, Mr. Barnard was up and then sent a representative there during the testing of the plant for three weeks. And everyone who has tested a filtration plant will understand the amount of help we received that could not be obtained in any other way. It was help we could not buy. Of course it was easy to procure the services of a chemist, but that is not the service of the State Board of Health. We appreciate the services they rendered us, and we find their willingness to co-operate with us has extended to other plants throughout the state. The impression among some water-works companies is that they want to keep away from the State Board of Health. One of our neighbors has that feeling, but no greater mistake can be made. What we want is co-operation, and it is from such meetings as this that we can get the benefit we need to make progress. I think the association owes a debt of gratitude to J. N. Hurty and H. E. Barnard for bringing us together and I shall look upon them as the fathers of this association.

A. H. Kennedy: In the matter of enforcing the care of public water supplies, it seeme to me there should be some way to get laws passed to make it mandatory, the same as the law compelling putting up fire escapes, etc. All the owners of buildings have been notified to put up fire escapes or quit business. Now it seems to me if some kind of an estimate could be made as to the amount of pollution which goes into White River from the sewers from each one of the cities along its course, and then an estimate as to the damage done by this sewage in deaths from typhoid, damage to property, etc., if a law was framed so that the cities which did not take care of their waste or compensate those who suffer damages they would then begin to do so. There is no question but what great damage is done throughout the state, and if this damage could be estimated and collected somebody would sit up and take notice.

THE PRESENT CONDITION OF THE WATER SUPPLY OF INDIANA.

By H. E. Barnard, Chemist to State Board of Health.

Prior to the establishment of the Laboratory of Hygiene of the State Board of Health, no systematic investigation of public or private water supplies of the state had ever been attempted. So far as the resources of the board would permit, investigation was made into the character of supplies supposed to be the cause of epidemic conditions, and much had been accomplished by private owners in the way of analyses of suspected wells and projected supplies, but all the data available are so meager and so subject to error as to be of little practicable value in determining and controlling the character of the water supply of the 37,000 square miles which comprises the state of Indiana.

No one thing enters so closely into the life history of man as does the character and quantity of the water supply which furnishes power for industrial operations, tempers climatic conditions and is constantly drawn upon for drinking and domestic purposes. I take it that it is the purpose of this convention to include in its deliberations the study of the water supply of this state as they affect all of these great factors of our civilization. The laboratories of the State Board of Health, however, are concerned only with the prevention and the suppression of disease. The water supply, furnishing as it does water for drinking and domestic purposes, becomes an important factor in determining the health of a community. Indeed it is the most important of all the agents which administer to healthful life. Certain diseases are largely water borne, particularly diseases of the intestinal tract, such as cholera and typhoid fever, and the quality of water supplied to perhaps 90 per cent of a town's population, is of first importance. This is realized more and more and the consumers today refuse to drink water that a few years ago was used without the slightest fear. Whenever typhoid fever is reported in a community, the water supply, whether it be from a well or the public main, should at once be brought under suspicion. And more than that, the water supply should be investigated before the fever breaks out. It is not enough to lock the stable door after the horse is stolen, though that practice is the one usually followed. Water supplies should be constantly subjected to rigid inspection. Their source should be of known purity, and every condition surrounding the distribution of the water such that contamination is impossible.

When this country was entirely agricultural, and the population widely scattered, the family water supply was of necessity the farmhouse well; but as the crossroads settlement grew to a village and with the passing years attained a city's attributes, the well became unsafe and the supply inadequate. Water became more and more a necessity; the few gallons that sufficed for the daily needs of the early settler would no longer satisfy the householder, who must have running water in kitchen and bathroom, sewer connections and lawn sprinklers. So public water supplies were sought and built either by private capital or public funds. Many cities and towns built their own water systems and sold the service to the consumer; many other supplies were constructed by companies or corporations looking for profitable investments. The service has extended until at present there are but few communities that do not have a water supply. Fire protection alone makes an adequate supply a necessity even where the water is not employed for domestic uses. With the rapid development of public water systems, there has not always been manifested the wisdom in a selection of a source of supply that is desirable. To the early settler, water was water, a fair conclusion where there could be no pollution; so it was that the first corporations building reservoirs and sinking wells consulted primarily the cost of installation and but secondarily the character of the supply. That policy did provide water-works, but as the years have passed by, one system after another has been abandoned at heavy loss and new ones constructed.

The water supplies of our state can be variously classified, but for our present purpose it is most convenient to discuss them under the heads of spring, well, and surface waters. In the class of spring waters we include those supplies which flow continuously or intermittently from the ground, or from fissured rock; well waters are those which are reached by an excavation either by digging or boring a cylindrical hole into the subsoil or stratum underlying the surface of the ground, the interstices of which are filled with water; surface waters include rivers, ponds and lakes, either natural water courses which carry away the accumulated rainfall or basins which store the water that drains from the surrounding watershed.

Spring waters have always been held in high repute as sources of domestic supply, and justly so, for springs as a rule yield water of a high degree of organic purity. Their water is derived from the rain which, falling upon the ground in a relatively pure condition, passes readily into the pervious soil. Soaking slowly through the soil, it reaches an impervious stratum along which it may flow for miles, losing by oxidation and filtration whatever organic matter it may have accumulated before it passed into the soil, and finally emerges at some rock fissure or gravel bed, clear and sweet, and as nearly pure water as nature furnishes. The amount of water yielded by springs depends upon the amount of rainfall absorbed by the collecting surface, and it is therefore proportional to the area of such surfaces. The character of the water depends upon the nature of the materials with which it comes in contact in its underground flow. If, for example, it passes through beds of gypsum, it will contain much sulfate of lime; if over beds of iron ore, it will be chalybeate in nature. In a word, its mineral characteristics will be that of the stratum through which it passes.

The surface waters of the state which before the development of industry were, without doubt, potable are at the present time for the most part loaded with waste products of manufacturers and the offal of nearly 3,000,000 people. Our great rivers such as the Wabash on our western border, the Ohio on the southern boundary and St. Joe in the north and the White River which drains the center of the state are trunk sewers utilized by every community on their watershed for carrying to the sea the waste products of our civilization. It has long been thought that running water would purify itself; that any sewage flowing into a river would be destroyed by oxidation in the course of twenty miles' flow, and chemical analyses have tended to support this assertion. For instance, the river Seine, which receives the sewage of Paris, becomes, fifty-five miles below the city, almost as pure as it was before the entrance of the sewage. Several factors are concerned in this apparent purification. Oxidation does occur to some extent. The experiments of the English Rivers Commission indicate that in flowing twenty miles from 20 to 30 per cent of sewage might, in summer, be destroyed by oxidation. Then precipitation is constantly going on, and suspended matter is rapidly removed by this means. But most of the apparent purification of running streams results from the great dilution of the sewage by the constant increase in the volume of a river, from both tributary streams and inflowing ground water. In this way the poisonous matters may be so diluted that they are beyond the power of chemical analysis to detect. Yet should the germs of disease have been present, they are still there, and as powerful for evil as ever. Dr. Frankland, a high authority on this subject, says: "There is no process practicable on a large scale by which sewage can be removed from water once so contaminated, and therefore I am of the opinion that water which has once been contaminated by sewage is thenceforth unsuitable for domestic use.

"If a stream has received much filth in its course, its waters should be considered objectionable, and to be avoided for human use, unless, indeed, the volume should be so great compared with the filth pollution as to be practically independent of such reasoning. If sewage contains the germs of disease, whatever they may be, no agent at present known, except a sufficiently high temperature, will efficiently destroy them."

It is altogether feasible to provide against the direct contamination of water supplies from sewage by requiring all communities to treat their sewage in such a manner that the effluent shall conform to a given standard of hygiene before it is permitted to go into our watercourses, lakes and ponds. From a moral standpoint they should feel obliged to render innocuous their sewage before allowing it to escape into the streams which furnish water supplies for their neighbors down the stream. The time is not far distant when legislation will compel such action and insure the continued purity of our water courses. Now that the effectiveness of the septic tank treatment has been demonstrated, no new sewage system should be introduced in the state without providing for septic treatment of the sewage, and as rapidly as possible the existing systems should be improved to conform to modern ideas. It is indeed fortunate that modern methods of filtration have made it possible to take these polluted surface waters and by proper treatment to remove from them 98 per cent. of the bacteriological content, and thus to render them again suitable water supplies. The degree of efficiency of modern methods for water purification is well illustrated by the fact that at the present time the great stockyards of Chicago are preparing to use as their water supply the sewage from the city mains, which by means of septic action and subsequent filtration is again made fit for human use.

The deep well supply is very popular with many cities and water companies. Deep well waters, that is, waters that come from strata lying in or below an impervious layer of stone or clay, in this State the limestone formations, are not liable to be contaminated by sewage and are more easily obtained and distributed than surface waters which have to be brought miles from their source or purified at great expense. Deep well waters are not desirable as public supplies for several reasons. In the first place the supply is always limited. If the watershed is large or if the wells are sunk in a valley which conveys underground waters flowing off an extensive watershed, the supply may be ample. But if the watershed is not large, the supply of water underlying it will be limited and no number of wells can obtain the necessary amount of water. It is inevitably the case that the deep well system gives out as the demand increases. Deep well waters are usually hard and frequently contain much iron. Hard waters are not desirable for domestic or laundry purposes and when used for making steam, have to be "broken" or softened before they are suitable for use. The deep well supplies now in use in Indiana are for the most part furnishing a safe water at the present time, and some of the systems are supplied with an abundance of water. But as far as the majority of the systems are concerned, it is inevitable that sooner or later the supplies will prove inadequate.

While our larger cities and towns rely on either the filtered surface water or ground water supply, at least 2,000,000 citizens of the state, inhabitants of the smaller towns and country districts, are dependent upon private wells for their water supply for drinking and domestic purposes. In the country districts no community system is possible and in many small villages the expense of installing a public supply is so great as still to necessitate the use of the well.

A well, whether bored, dug or driven, is simply a cylindrical shaft extending down into the subsoil or stratum underlying the surface. When a pervious subsoil of sand, gravel or limestone overlies an impervious material, such as clay or granite, a portion of every rainfall enters the subsoil and, being held up by the impervious layer below, tends to accumulate. The water thus held in the interstices of the rocks lying immediately beneath the soil is "subsoil" or "ground" water, and constitutes about 40 per cent of the soil which it occupies. Its surface is not level, but slopes towards its natural drainage outlet, from two to eight feet to the mile. The water thus forms a subterranean river, always flowing in one direction. A well penetrating the stratum through which this river flows is filled by the water to the same height that it occupies in the soil. If the water in the well is wholly undisturbed there will be a constant but imperceptible current in it in the direction of the flow of the ground water, and there will be no flow into the well save in one direction. But if the well is freely drawn upon so the level of the water is below that of the water in the surrounding earth, inflow will take place from all directions. This inflow is liable to take place from a distance of one hundred feet laterally, and from a much greater distance in the direction from which the ground water flows. Hence we may accept it as a fact that filth within one hundred feet of a well will influence the character of the water. But this is not the whole truth, for the original source of filth may be much further away and have gradually defiled the soil in the direction of the well until it extended within its influence. Cesspool filth has been known to permeate through the soil for a distance of two hundred yards and poison wells.

In a small rural village the supply of water from wells may have been of unexceptionable quality for an indefinite time, but the place grows, population becomes more dense, the ground water is drawn upon in excess of the supply, the drainage area of the well is increased, and the water becomes less pure both from this cause and from the increased amount of sewage returned to the soil, which is sure to become saturated beyond its power of oxidation, and pollution of wells is inevitable. Wells should be abandoned as a source of water supply for household use whenever there are more than two houses to an acre of land.

In view of the fact that the public supply properly operated and constantly guarded is installed in all of our cities, we would expect that wherever possible the householder would connect with the city main and abandon his well, which, originally pure, has at length in almost every instance become grossly polluted. Distrust of the public supply so frequently is responsible for a continued use of the polluted water. Many men guard the honor of their family well as sacredly as the honor of their name and refuse to believe that a water which has been used for generations can be other than pure. However praisewothy this attitude may be, it is wholly wrong. Only sickness will teach what sanitary science has failed to do. The blind faith in the purity of well water is one of the chief reasons why typhoid fever so constantly ravages the country districts. We have heard time and again the statement: "My well water is the best in the county," and have found by analysis that it was little superior to raw sewage; clear and cool, perhaps, but nevertheless reeking with the putrefactive bacteria of the privy vault and the filthy hog-pen.

The condition of the private well is best illustrated by the following figures, which show clearly our work of the last two and one-half years as well as what will have to be done before the character of the water used by the country householder is as good as that supplied the citizens of towns where the public supply is used.

If these figures are summarized we find that 1,252 private well waters have been analyzed, of which 595 were pure, 509 bad and

148 of doubtful quality. If we class the doubtful waters as bad, since they will eventually reach this condition, we see that 657, or 52 per cent., of the private well supplies are of such quality as to be unsuitable for drinking and domestic use. If this figure holds good throughout the state we can readily see why the typhoid returns from the country districts are always high. Making another classification based on the source of the waters, we find that of 392 deep well waters analyzed but 70 were bad, 39 doubtful and 283 were of good quality. The deep well is evidently a satisfactory private supply if it is derived from true second water. Of 797 shallow wells 417 were undoubtedly bad, 276 were good and 104 were of doubtful quality. It is not surprising that many wells are polluted, because the universal custom of grouping the house, barn and water supply within easy reach of each other has made the well the center of drainage area for all household sewage and farmyard waste. Great numbers of these old wells are still in common use, and, save where analysis has proven the water to be a filtered sewage, of good repute in the community. The importance of an analysis of these well waters can not be overestimated. In some towns where public sentiment has been aroused, a series of analyses has shown that hardly a single well in the thickly settled village was suitable for use, because of the presence of sewage effluents. Where such conditions exist, and our results convince us that they are by no means uncommon, a water supply brought from some uncontaminated source becomes a public necessity.

In comparison with these figures we will turn to those representing the water from the public water supplies. In all, the 394 water samples from public supplies have been analyzed, and of this number 257 samples were of good quality, 52 were bad and 85 were of such character that they were classed as doubtful. Most of the bad waters were taken from shallow or driven wells located in the public square or by the side of the street, where they were exposed to all sorts of pollution. In order to better illustrate this point we have made another classification based on the source of the sample. Of the 200 deep or subsurface waters used as public supplies, 148 were entirely free from pollution, 11 were classed as bad and 41 were of doubtful quality. Several of the bad and most of the doubtful waters were so classed because of the high content of ammonia, chlorine, and iron present, and not because there was any evidence of pollution by sewage. Certain waters, especially those from the coal and gas belt, have a high chlorine and ammonia content, which renders them undesirable for drinking or domestic use, although there is no claim that such waters are capable of producing disease. Of the shallow or surface wells but 20 could be passed as pure, while 21 were undoubtedly bad and 13 were evidently in a transition stage from good to bad. If we class these last wells as bad, a condition they will doubtless reach eventually, we find that but 20 out of the 54 shallow wells used as public supplies were above suspicion. But 55 of the 84 stream supplies were pure, 9 were undoubtedly bad and 20 were receiving sewage either directly or as the runoff from cultivated and inhabited ground. None of the 27 pond supplies were bad, although 8 were of doubtful quality. Of the 29 springs, 15 were good, 11 bad and 3 of doubtful quality. It is not probable that these bad springs were true spring supplies. They were evidently waters draining off inhabited areas and breaking out at some fault a short distance below the surface, rather than deep ground waters. Knowing, then, that many of our public supplies are already somewhat polluted, or are liable in the near future to become unfit for use, and that the private well supplies of which there are more than 500,000 in the state, are, in at least 50 per cent of the cases, already contaminated, the work of the State Board of Health in correcting present conditions and in insuring the health of later generations, becomes a task of great magnitude and inestimable value. It is possible through the laboratory to determine present pollution and slowly to close dangerous city and country wells. It is also possible to assist the operators of public supplies in those cases where they do not already maintain as they should their own laboratory staff, but as the work goes on, I am impressed more and more with the fact that more stringent legislation is necessary; that the character of the water supply, both public and private will continue to deteriorate until positive law is enacted that will make it imperative upon the community and the householder alike to care for sewage and household waste in a sanitary manner. But as with legislation along other lines, law enforcement only becomes practicable and can be accomplished efficiently when in accord with educated public sentiment. When the people realize the economic cost of water-borne disease, when they understand that one death from typhoid fever costs the community more than pure water, when the city dweller can be made to appreciate the fact that the cesspool in the backyard becomes inevitably a source of water supply for his well, and when the country dweller learns that water from a surface well is dangerous, we may expect not only proper legislation but consistent compliance on the part of citizens that will eradicate the scourge now imposed upon us.

BOOKKEEPING FOR SMALL WATER-WORKS PLANTS.

By Dow R. Gwinn.

In designing a system of bookkeeping for water-works plants, there are two important features to be kept in mind: 1st, Simplicity; 2d, Comprehensiveness.

The system should be as simple as possible so that the work can be reduced to the minimum, and it should be comprehensive to the extent of enabling anyone to get the detailed receipts and expenses and to determine the condition of any account in a few minutes' time.

CONSUMERS' LEDGER.

The form here described has been used by the writer for a number of years, and has proven very satisfactory. The writer believes that an account should be kept with every service connection; that the ledger should show every connection, whether in use or not; that the accounts should be arranged in the ledger in regular order along the different streets. This can be done by blocking out a plan to suit local conditions. In Terre Haute, we begin with the streets adjoining and running parallel with the river (known as Water street), then First street, then Second street, and so on until all the streets running north and south on which there are customers, are taken; then we take the streets running at right angles with the river. With this arrangement of the accounts, it is not necessary to refer to the index very often, except for the new connections that were made after the books were opened. The form can be used either for annual, season or metered consumers and is arranged for four years—annual rates quarterly, and meter rates monthly. Provision is made for changes of occupants. A list of the principal uses with spaces for detailed charges is provided. Columns are arranged for records of shutting off and turning on. The quarterly or monthly charges are entered with a pen and when paid a rubber dating stamp is used. Spaces are provided for list of fixtures, date when meter is set, number and name of same, rate, result of test, when contract expires, also for memoranda of additions and changes in rates. If necessary, records of locations of corporation cocks and service or pave boxes, size and material of the pipe can be added. A book of this kind with, say 1,000 accounts, will cost in the neighborhood of $25.00 to $30.00. We had six books made with 1,500 accounts in each for $130.00 or $14.40 per thousand accounts.

CASH RECEIPT BOOK.

This is simply a cash book with a number of headings, such as annual rates, meter rates, miscellaneous revenue, service construction, etc. There is also a space for the ledger number and spaces for dates to show the period the amount pays for. With this method of entering receipts it is easy to determine the total amount paid by each class of customers. A book of this kind with 600 pages and 45 lines to the page cost us $14.00. Where the plant is small and the business not large enough to warrant the purchase of a special book, the writer would recommend what is known as a trial balance book, with six double columns made by the Marshall-Jackson Company, 144 Monroe street, Chicago. This book is known as No. 90. The price of a two-quire book, 10¼x15½ inches, is $2.35; three quires, $3.25. The six double columns can be used as twelve single columns, and the twelve headings can be written in to suit the business. There is a stock book known as No. 23, six-column journal, with 300 pages, which sells at $2.00, can be purchased at almost any book store and can be adapted to suit the requirements of a small business. The writer is using these books in three small water-works plants and the men in charge are pleased with them.

VOUCHER SYSTEM.

The form described has been in use for a number of years in two plants in which the writer is interested. For small plants, the writer has used a book known as a 24-column journal, No. 7524 M-J Co., 150 pages, cost $1.30 each. These books have no printed headings. There is a larger stock book made by the Marshall-Jackson Company known as Blank Balance Book, Form 21077, 11½x17½ inches, with cut leaf, 42 horizontal lines and 27 columns, price $3.20 for two quires, and $4.30 for three quires. There are no printed headings in this book.

All distributions of every character should be vouchered and the amount distributed under whatever head it may belong. There should be a receipt for every payment that is made, although it is not necessary to have a voucher for every small payment; for instance, a number of receipts for express charges, postage, laundry and all petty payments can be pasted in one voucher. This voucher could be marked "Petty Payments"; however, the payments should be distributed under the different heads just the same as any other voucher.

A voucher should be made each week and marked "Pay Roll." In this voucher will be included payments for labor, other than the regular salaries. A voucher should be made for the superintendent, engineer, etc.

In the back part of the voucher book can be kept an account of the totals for each month, using one line for each month and then entering the total payments for each item under the proper headings. By entering these amounts at the end of each month and putting in red ink totals, it is easy to determine what has been spent for any purpose from the first of the year up to the end of any month.

The following is taken from the December, 1904, number of "System," which will be of interest in this connection:

"The voucher, as an instrument in accounting, serves six distinct purposes:

"In the first place it is the most satisfactory method for making systematic the course of a bill from its receipt to its payment, and compels every bill to go through a certain regular procedure.

"Second, it affords opportunity for approval of every bill by the auditor and the manager or proprietor, thus preventing any payment from being made without their knowledge and oversight.

"Third—and this is its primary function—it serves as a ledger account with the creditor, obviating the necessity of opening a ledger sheet with each seller from whom the firm buys; for on its face it holds a detailed record of the firm's transaction with the creditor during this month.

"Fourth, it acts as a distribution ledger, for every expenditure is distributed to its proper charge account.

"Fifth, when returned by the seller the voucher serves as a receipt; it affords double check on all remittances, for, since the check number is on the voucher, the creditor receipts also for the medium through which payment was made.

"Sixth, it binds together all data bearing on the firm's transactions with any house from which it buys.

"When the bills are complete, the bookkeeper makes up a voucher. On the face of the voucher is written the name and address of the creditor, and the dates and total amounts of the individual invoices of the past month. All the invoices and the statement are pasted on the face of the voucher. This is done in order that the auditor and the final approver may have all the data necessary for passing judgment on the voucher, and so that the creditor may know just what he is being paid for. The bookkeeper writes on the reverse of the voucher its number, which is one of a consecutive series, the total amount, the name and address of the creditor and the month covered by the voucher.

"The bookkeeper also distributes the expenditure represented by the voucher to the proper charge account. On the reverse side of the voucher are printed the various accounts into which the debtor firm classifies its charges. Opposite each classification the bookkeeper posts that part of the expenditure which is chargeable to it.

"Each creditor will have a single entry on each month's sheet of the distribution voucher, which will be the total of his business with the firm during the month. The total amount of each account is placed in the first column. The bookkeeper distributes this amount under the proper headings in the other columns, in accordance with the distribution which he has indicated in the voucher.

"In place of a ledger index the bookkeeper needs only have a card index of all his creditors, alphabetically arranged; on these he enters, each month, the number of that firm's voucher for the month, and its page of entry on the distribution ledger. This enables him not only to turn to the account of his house in the distribution ledger, but also to go direct to the itemized voucher containing the original statement and invoices. In other words, it is the same as, and even better than being able to turn to the creditor's itemized ledger.

"When the voucher is returned, receipted by the creditor, it is a receipt for that amount of money. Since the amount of each invoice included in the vouchered sum is posted on the voucher, it is an acknowledgment from the creditor that these certain bills have been paid.

"The voucher is then filed in its numerical order in an elastic voucher file."

OPERATING EXPENSES.

Include all expenses of operating and maintaining the plant, including small supplies, packing, etc., repairs, etc. General expense and maintenance are part of the "Operating Expenses."

BETTERMENTS.

Under this heading should be entered the payments for betterments to the plant, such as new pumps, engines, boilers, buildings, reservoirs, wells, etc. At such times as there is general construction work being done, an extra page could be used each month and subdividing ''Betterments'' by writing in whatever headings that are necessary. However, all payments that are made out for ''Betterments'' should be included under this head, notwithstanding that subdivisions are made; in fact, the subdivisions would be for details only.

EXTENSIONS.

Under this head should be entered all payments for cast iron pipe, specials, lead, yarn, valves, valve boxes, hydrants, and labor, and anything that entered into the pipe system. This would include the freight, drayage, and any expenses in connection with the same. In fact, freight and drayage should always be charged under the headings for which they properly belong.

METERS.

Under this head all payments for meters, meter couplings, meter boxes, labor in setting, pipe fittings used in setting, freight, express or drayage charges.

SERVICE CONSTRUCTION.

Under this head all payments for service pipe, corporation cocks, curb cocks, lead connections, service boxes, drayage and labor in putting in services, should be charged.

OFFICE FURNITURE AND FIXTURES.

Under this head should be charged all payments for permanent fixtures or furniture used in the office.

TREASURER.

All amounts sent to the treasurer should be accompanied with a voucher so that there would be a receipt for the same and the amount charged accordingly.

RENEWALS AND REPLACEMENTS.

This is a head which will not be used very often, but is intended for such payments as cover the renewal of any part of the plant.

BOND INTEREST.

All payments for bond interest are included under this head, but any payments to the Trustee for paying coupons, etc., is charged under the head of "General" in operating expenses.

SUNDRY INTEREST.

All interest charges on floating debt and on money borrowed temporarily is charged under this head.

WATER REBATES.

Where water is shut off and a rebate given, a receipt should be taken for the amount and entered under this heading.

RETURNED METER DEPOSTIS.

Where there is any question about getting paid for water furnished by meter, it is customary to ask the consumer to make a deposit, and when the water is ordered off the deposit is returned to him, a receipt taken and entered under this heading.

OPERATING EXPENSES IN DETAIL.

EXTRA LABOR AT STATION.

This heading is for payments for extra help at the station, outside of firing.

GENERAL LABOR.

Under this heading, all payments for labor in shutting off and turning on water, reading meters, etc., is entered.

METER REPAIRS.

Expense of repairing meters, including material for the same, is charged under this heading.

OFFICE EXPENSE.

Under this heading will be placed sundry expenses, such as laundry, special cleaning, fees for filing statements, analyses, subscriptions to papers.

GENERAL.

Under this head should be charged anything which cannot be placed under the other headings, and care should be used to see that it is not overburdened, because ordinarily it will not be necessary to use this column.

STATION SUPPLIES.

Included under this heading would be packing, waste, oil, belting, belt dressing, boiler compound, and other engine supplies.

All drayage, freight and express charges should be distributed under the headings where they properly belong. For instance, if a frieght bill on a barrel of oil is paid, it should be charged under "Station Supplies"; a charge for drayage on packing should also be charged under this head. An express charge on some parts used in repairing the pump should be charged under the head of "Pump Repairs"; a wheelbarrow used by the firemen would come under the head of "Tools," while freight and drayage charges on the same would also come under this heading.

GENERAL CASH.

Where the business is small, a general cash book is not necessary, as the totals can be entered on a page in the back part of the book, using one page for each month and one line for the total receipts for each day. By taking one page for the entire year, and using one line for each month and adding each month to the totals for the preceding months, the receipts for any month, or up to the end of any month can be seen at a glance. For instance, the monthly totals for January and February are entered with black ink on the first two lines. On the third line is entered with red ink the totals of the receipts for January and February. After the totals for March have been entered on the fourth line, the totals up to March 31st are entered with red ink on the fifth line. Those who have tried this plan are pleased with it. The same plan is used in the voucher book. The great advantage is that the total receipts and disbursements *in detail* for any month for the period, from January 1st up to the end of any month can be seen at a glance. Comparisons with months or periods of months in other years can readily be made.

The general cash book can be used with advantage where the business is large enough to justify it. Only the totals of the entire month are posted in the ledger. For instance, the column showing the collection on the different days in the month, say from metered consumers, is footed and the total is posted into the ledger account. This means only one entry in the metered consumers' account in the ledger for the entire month. It also means a great saving in time, and "time is money."

JOURNAL AND LEDGER.

Of course, it is necessary to have these two books, and they can be ordinary stock books or special books, depending upon the taste of the officials in charge and the size of the business. The writer would recommend that 1-12 of the annual taxes and bond interest be charged up each month. Also that at the end of each year, a certain amount be charged off for depreciation. The life of cast iron may be fixed at 100 years or even longer, but other portions of a water plant, such as boiler, pumps, meters, etc., do not last as long and it is well to make provision for the day when renewals must be made.

FILING ENVELOPES.

Reports from plumbers and inspectors can be taken care of by having an envelope for each service pipe. These envelopes are made of stout manilla paper and bear the application number which is also the filing number. A card index in connection with the envelopes completes this system.

RECORD OF STREET MAINS.

The form submitted herewith is for record of pipe laying on one side of the sheet and for private service pipes on the other, each sheet being arranged for one block.

At the conclusion of the conference it was suggested that a permanent organization be formed of the members of the several boards of health and the water supply companies of the State, and that Dr. F. A. Tucker, chairman of the Conference, select a committee to draft a suitable constitution and by-laws and report at the dinner to be given at the Claypool Hotel at 7:30 that evening.

At the close of the Conference, members and visitors were the guests of the Indianapolis Water Company and enjoyed an automobile ride to the filtration plant and pumping station.

FOURTH SESSION.

Thursday, July 9, 8 p. m.

At the evening meeting, upon motion of Mr. Boyd, J. H. Brewster was unanimously selected as temporary secretary.

Upon motion of Mr. Landon, the conference proceeded to take up the recommendations of the committee section by section.

The name of the proposed organization, recommended by the committee was discussed, several suggestions made, and motions were made looking toward the modification of the name.

Upon motion of Dr. Hurty, the name finally adopted was the "Indiana Sanitary and Water Supply Association in Affiliation with the State Board of Health."

The object of the association was passed as recommended by the committee.

Section 3, under article 3, was amended, adding the retiring President to the membership of the Executive Committee.

Section 4 of article 3 was amended, giving the Executive Committee the authority to determine the time and place of each meeting of the association.

Upon motion of Dr. Hurty the constitution and by-laws, with the above noted amendments, was passed as a whole.

CONSTITUTION.

Article 1. Name.

The name of this association shall be the "Indiana Sanitary and Water Supply Association in Affiliation with the State Board of Health."

Article 2. Object.

The object of this Association shall be the study of the sources of water supply in the State of Indiana, their conservation and purification.

Article 3. Officers.

Section 1. The officers of this Association shall consist of a President, five Vice-Presidents, Secretary and Treasurer. All the above officers to be elected annually by ballot, and shall serve for one year, or until their successors are elected.

Sec. 2. The President shall preside at all meetings. In his absence one of the Vice-Presidents shall preside.

Sec. 3. The officers of the Association, with the retiring President, shall, ex officio, constitute an Executive Committee.

Sec. 4. The Executive Committee shall have the management of the affairs of the Association, may suggest topics for discussion, and shall have power to expend the funds of the Association, provided that no indebtedness shall be incurred exceeding the amount of the funds in the hands of the Treasurer, and shall determine the time and place of all meetings.

Sec. 5. The Secretary shall keep the minutes of all meetings, conduct all correspondence, receipt for all fees and dues, and turn over to the Treasurer all moneys received, taking his receipt therefor.

Sec. 6. It shall be the duty of the Treasurer to receive from the Secretary all money for the Association, to keep correct accounts of all receipts and expenditures, and pay all demands against the Association when approved by the President. At each stated meeting he shall exhibit a statement of his accounts.

Article 4. Membership.

Any citizen of the State of Indiana, interested in the sources of water supply, its conservation and purification, members of Health Departments in the State of Indiana, water chemists and bacteriologists, and mayors of cities and towns of the State of Indiana, shall be eligible for membership and shall make a written application to the Secretary, stating his name, age, residence, business, and position, accompanying his application with the regular initiation fee. The Secretary shall refer each application to the President, and with his approval shall issue a certificate of membership.

Article 5. Amendments.

Amendments to this Constitution and By-laws must be in writing, and may be made at any regular meeting by a vote of two-thirds of the members present.

BY-LAWS.

Article 1. Meeting.

The time and place of the annual meeting of the Association, for the election of officers and transaction of business, shall be fixed by the Executive Committee.

ARTICLE 2. ORDER OF BUSINESS.

The President shall take the chair at the appointed hour, and the order of business shall be as follows:

1. Roll call.
2. Reading of minutes of last meeting.
3. Reading of all letters and communications.
4. Reports of Secretary, Treasurer and Committees.
5. Unfinished business.
6. New business.

ARTICLE 3. DUES AND FEES.

The membership fee shall be One Dollar. The annual dues shall be Two Dollars.

Upon suggestion of Chairman Tucker, the Association took up the election of the standing officers of the Association for the ensuing year.

Upon motion of Mr. Gwinn, H. E. Barnard was elected President of the Association. Mr. Barnard responded to calls for a speech, and, after thanking the Association for the honor conferred upon him, took up the discussion at some length of the purpose of the organization and what it was expected to accomplish.

Upon motion of Mr. Landon, Dow R. Gwinn was elected First Vice-President.

Upon motion of Mr. Boyd, Howard A. Dill was elected Second Vice-President.

Upon motion of Mr. Stillwell, B. F. Von Behren was elected Third Vice-President.

Upon motion of Mr. Oliphant, Quince Walling was elected Fourth Vice-President.

Upon motion of Dr. Hurty, Severance Burrage was elected Fifth Vice-President.

Upon motion of Mr. Gwinn, Frank C. Jordan was elected Secretary.

Upon motion of Mr. Boyd, George A. Fletcher was elected Treasurer.

President Barnard took the chair.

At the request of Mr. Davis, Mayor Bookwalter, who was present, made a short talk to the members present and assured them of his hearty support and co-operation along the lines of the purpose of the organization.

Mr. Dabney H. Maury, ex-President of the American Water Works Association, talked at some length upon what we may have a right to expect from the harmonious work of this Association with the State Board of Health.

On motion of Dr. Hurty the meeting adjourned.

(Signed) H. E. Barnard,
President.

Frank C. Jordan,
Secretary.

LIST OF MEMBERS OF THE CONFERENCE WHO UNITED TO FORM THE ASSOCIATION.

Indianapolis, Ind., July 8, 1908.

We the undersigned, desirous of forming an Association for the study and exchange of information pertaining to the sources of water supply in Indiana, their preservation and purification, do hereby associate and adopt the Constitution and By-Laws:

H. O. Garman,
J. A. Craig,
Will W. Kemper,
John W. Peck,
J. W. Smith,
Carl R. Semans,
Wm. E. Taylor,
Wm. Curtis Mabee,
John Langan,
M. Stillwell,
Severance Burrage,
H. E. Barnard,
J. Herbert Brewster,
Chas. Brossman,
A. H. Kennedy,
E. L. Loomis,
F. W. Witherell,
Dow R. Gwinn,
J. W. Robb,
B. F. Von Behren,
Harry E. Jordan,
Chas. C. Brown,
Chas. A. Tripp,
Geo. M. Brown,
W. J. Cain,
Dr. J. N. Hurty,
Dr. Eugene Buehler,
Dr. Frederick A. Tucker,
T. W. McNance,
Quince Walling,
Howard A. Dill,
Geo. A. Fletcher,
John Oliphant,
Edward DuBois,
Hugh McK. Landon,
Frank C. Jordan,
F. A. W. Davis,
L. C. Boyd,
E. Dixon,
Frederick Schafer.

RESOLUTION FOR THE PROTECTION OF THE WATER RESOURCES OF INDIANA.

The following resolution was adopted at the Conference of Municipal and Private Owned Water Plants of Indiana, with the State Board of Health, in session July 8-9, 1908:

Whereas, It is plainly apparent that the ground water supply is slowly diminishing in all parts of Indiana, and is rapidly diminishing in the White River watershed; and

Whereas, The surface supply (streams and lakes) is also plainly growing less yearly, and pollution is accumulating and increasing, thus threatening the very life of the people; and

Whereas, The municipal water supplies of the future must be drawn from surface supplies, therefore, be it

Resolved, by the Conference of Municipal and Private Owned Water Plants of Indiana, with the State Board of Health, in session July 8-9, 1908, That the people should arouse to the very serious situation that exists, and at the earliest practicable moment secure from the General Assembly such wise and just legislation as may seem best to conserve the streams and lakes, and protect them from pollution; and be it further

Resolved, That a committee of three shall be appointed by the President to formulate an address to the people, which shall, in the name of the Conference, set forth the facts in regard to the diminishing water supply and the urgent necessity of reforestation of such areas as may be found by investigation will be required to increase and conserve the surface waters.

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